NEW YORK SEATTLE

MOTORSHIP

Devoted to Commercial and Naval Motor Craft

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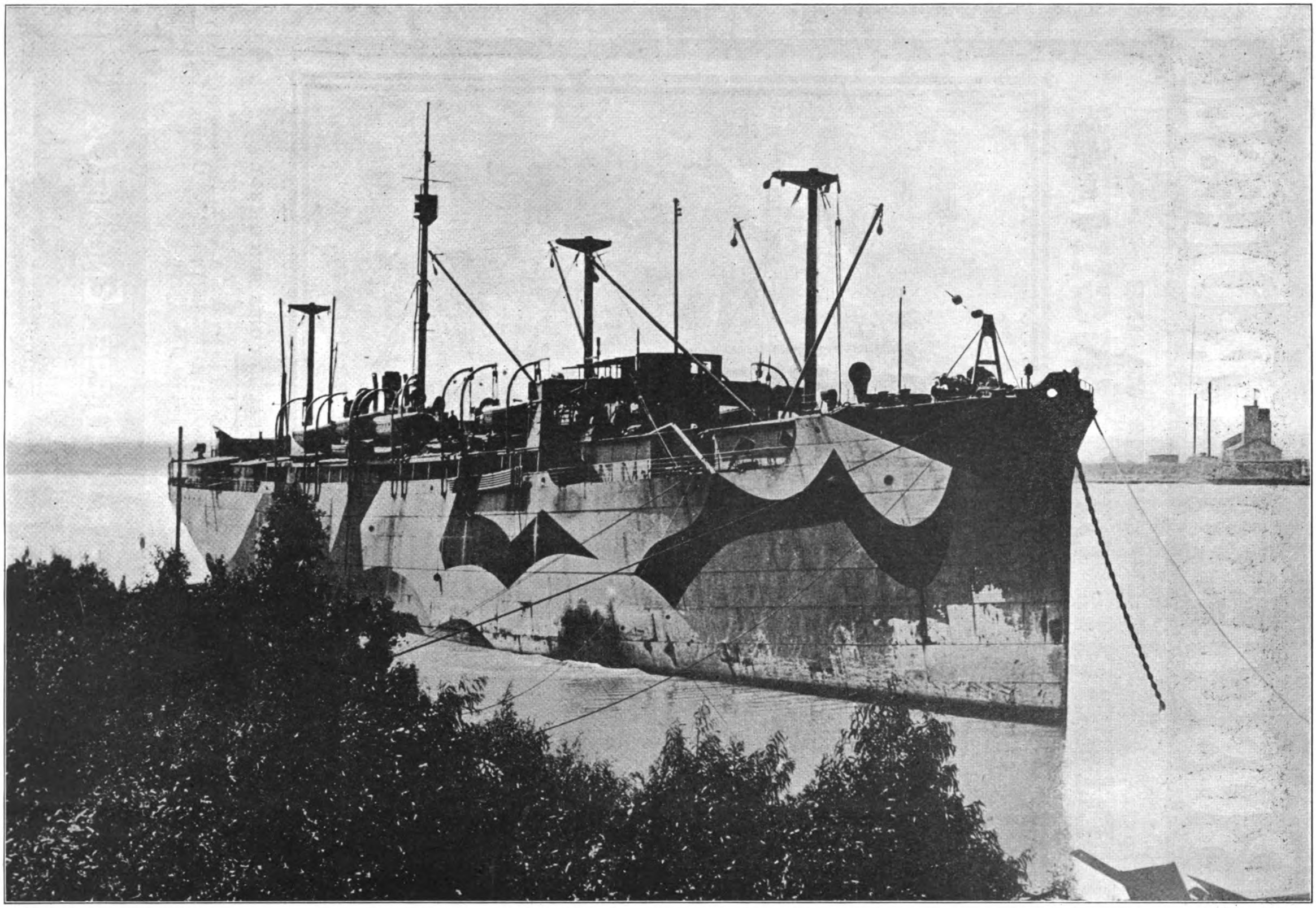

NOTEWORTHY ECONOMICAL MERCHANT SHIPS—No. 5

The British transport-cargo "GLENAPP," which is the highest powered Diesel-driven freighter in the world, in all the glory of her war paint. In addition to 8,460 tons of net cargo she can carry 1,700 troops across the Atlantic at an average speed of 14 to 15 knots on 24 tons of oil-fuel per 24-hour day. She was built by Barclay Curle & Co. of Glasgow, and was engined by Harland & Wolff's Diesel Engine Works. Length O.A., 470 ft.; length B.P., 450 ft. 5 in.; breadth, 55 ft. 8 in.; depth, 36 ft. 6 in. Power 6,600 to 7,000 I.H.P. at 125 R.P.M. On her last voyage to Liverpool she carried cotton from New Orleans. Soon she may be carrying American cotton when American *STEAM* ships may be laid up, due to their high operation costs and probable lower freight rates.

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MOTORSHIP

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AND FOR RECORDING PROGRESS OF THE MARINE
INTERNAL-COMBUSTION-ENGINE

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The oil-engined motorship has arrived! It is such a pronounced economy that it was bound to come. Nothing could stop it! And all obstacles have been removed as fast as they arose. The law of progress has seen to that. Very strong prejudices stood in the way of steam. But, one after another they were swept aside and steam reigned triumphant for a century. Steam now has had its day! Its zenith has passed, and gradually but surely it is being superseded by the economical internal-combustion power. America, the most important oil-producing country, is to be the greatest motorship-owning nation. Let us all co-operate and assist to make that day soon.

EDITORIAL

THE FALLING OF THE BAROMETER

Dark Outlook for American Overseas Steamship Operation—Salvation Rests With Rapid Conversion of Existing Vessels to Motor Power

FEW American shipowners expected such a great cut in ocean freight rates to come so quickly as those of nearly a month ago, and if another reduction of so radical a nature follows—as undoubtedly will take place at no distant date—it will hardly be possible for American steamships to compete profitably against foreign steamers and economical motorships in carrying domestic commerce to other countries, not to say the products of foreign countries needed by American importers. Many shipowners once again are operating their own steamships, so the situation is important to them.

Consequently no surprise need be evinced in the quick response to the urgency of the situation made by the U. S. Shipping Board Emergency Fleet Corporation by suspending all contracts for steam-driven cargo ships upon which actual work of importance has not been commenced, with a view to changing the orders to a more economical class of ship and to make certain that the Corporation is justified in substituting a new type of vessels. Only a minor number of the Shipping Board officials remain who are not yet thoroughly convinced that the large, fast and economical Diesel-driven motorship is the only type of ocean cargo-carrier that will enable America to stand another drastic cut in the freight rates, and that the suspended vessels must be changed to motorships before further money is spent on them, and that additional motorships must be ordered.

The old parrot-cry "I told you so" never sounds pleasant but sometimes it is advisable to reiterate a warning. Last autumn an official announcement indicated that America's new great merchant marine would not be used against cessation of hostilities for making a trade war against our gallant allies. In our issue of October last, we felt it necessary to indicate that even if America did not compete against other countries, they would compete against us. What we said was:—

> "Fair competition—even if strenuous—produces business that otherwise would not exist, and without foreign business many nations would go bankrupt. Obviously then, after the war, all countries will strive for "supremacy" in international trade. Consequently, although it will not be started by the United States after peace has been declared and affairs become settled, there is bound to be such a tremendous competition among all countries for the carrying of freight on the high-seas that the resultant friendly business rivalry virtually will form something approaching a trade war, once the amount of goods to be carried is less than the capacity of ships in service."
>
> "The very future and prosperous existence of many countries will rest with their success in securing extensive international trade, and unless a nation's ships can carry produce as cheaply as those of other countries, she cannot be prosperous continually. That is why America previously has been a third-rate maritime commercial power."

Although it is only a few months since the Armistice was signed and the World peace has not yet been officially declared, the recent large drop in freight rates first made by British shipowners is an initial confirmation of our remarks and a taste of what is to come. Once more we will look ahead and state that before long the only transocean cargo vessels flying the American flag will be Diesel-motor driven, and the greater majority of American ocean steamers either will be tied-up in port or sold to foreign buyers at low prices, unless they are Federal operated with the tax-payer bearing the heavy burden. But, we believe that during the next few years many existing steamships will be converted to heavy-oil motor power. That is their only salvation for future operation at a profit. We do not wish to appear pessimistic, but it is foolish to ignore facts which obviously are staring shipowners in the face. America can have a great and successful merchant marine, but not a successful **steamship** merchant marine. In motorships rests our sole opportunity. Let shipowners watch that the barometer does not fall too low before taking adequate action.

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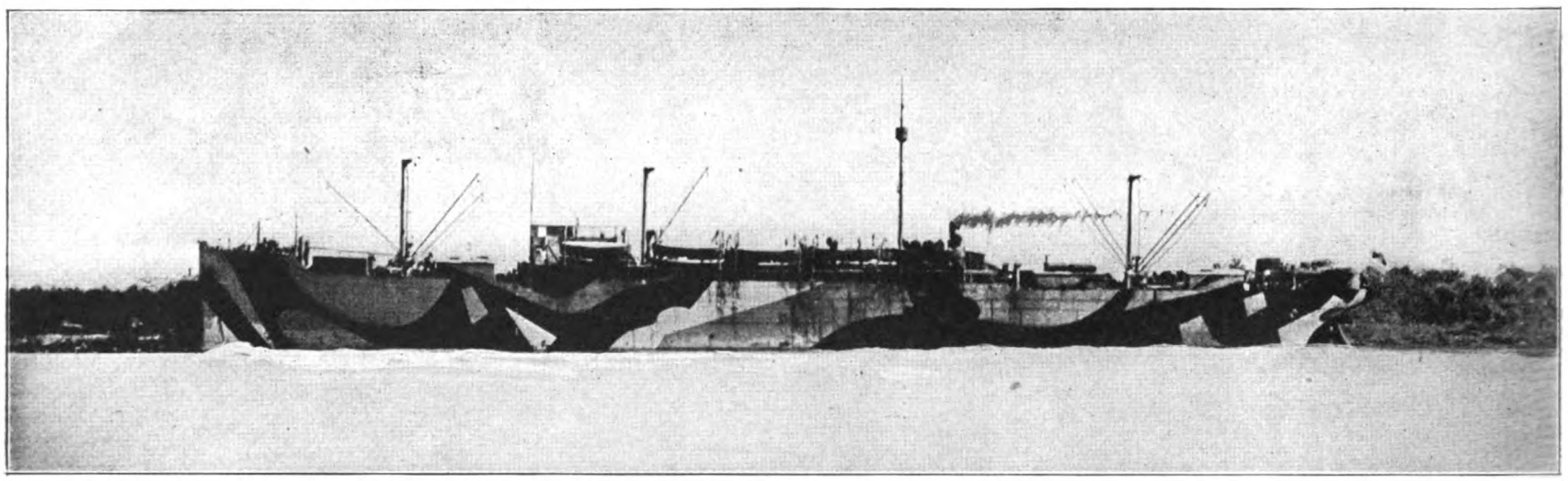


The British m.s. "GLENAPP" leaving New Orleans with a cargo of American produce (cotton) for Liverpool, England. Can American steamships carry American cotton in competition with her? Why not convert every American cargo steamer to Diesel power? Then our merchant fleet will remain on the seven seas.

Diesel-Electric Drive For Motorship Propulsion

Reasons for the Adoption of this Type of Power for Large Merchant Ships

By G. C. DAVISON

Vice-President, New London Ship & Engine Company, Groton, Conn.

[In "Motorship" for April, 1918, an article was published which formed an argument against the use of electric drive for the propulsion of Diesel engined motorships, so we gladly give space to Mr. Davison's interesting contribution—EDITOR.]

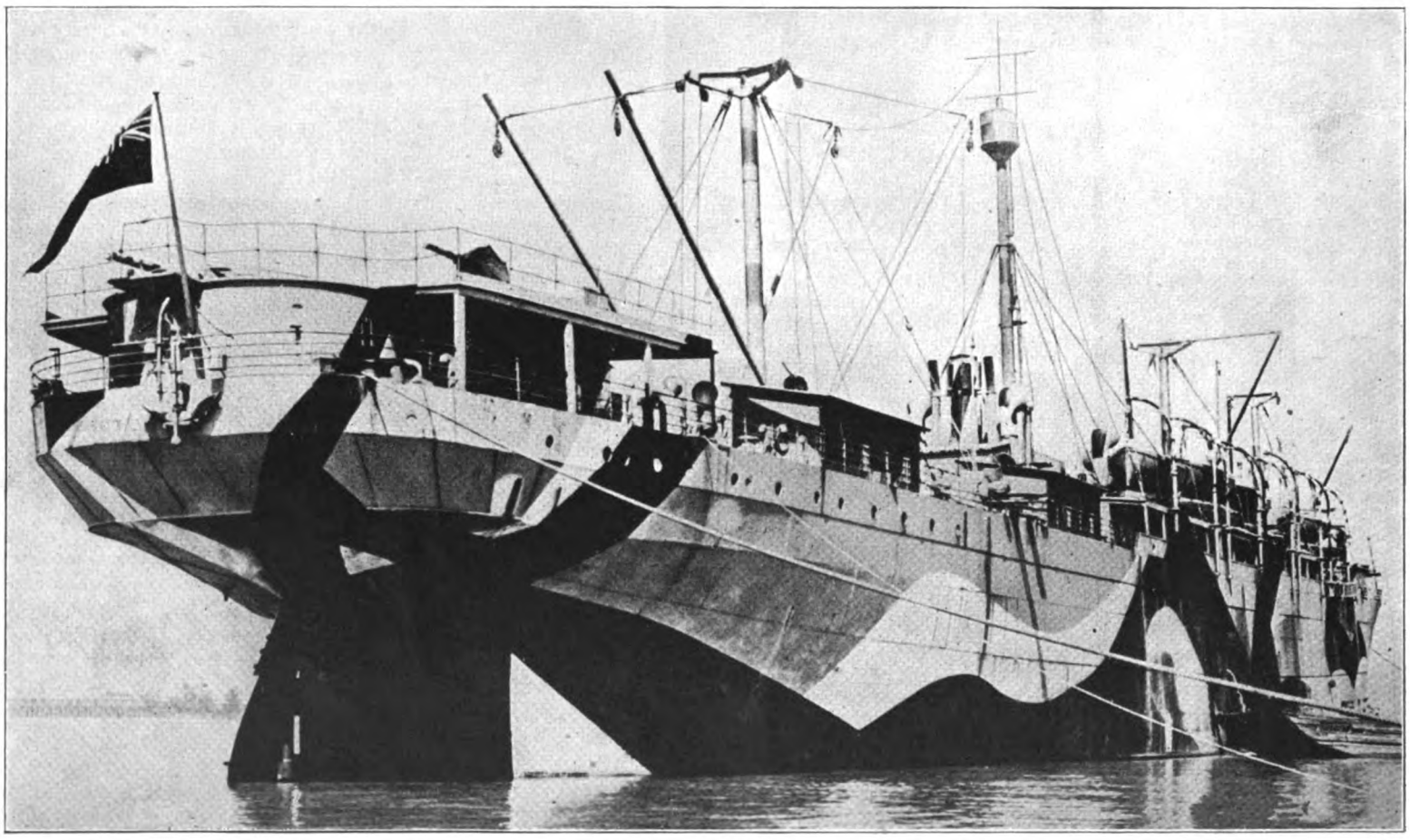
As a direct result of the war, and the sinking of merchant ships by German submarines, the United States is in the midst of the most extensive merchant shipbuilding program that the world has ever witnessed. To carry out this program, there was created a government institution very aptly named—The U. S. Emergency Fleet Corporation. The ships now under construction might very well be called an emergency fleet. As was most natural and unavoidable, such a fleet is composed of a variety of different kinds of ships, such as wooden ships, steel ships of various sizes, and equipped with machinery of various types.

There has of course been considerable discussion and criticism in regard to some of the designs, but it should be remembered that there was an emergency to be met and it was a case of getting the kinds of propulsive machinery available in the quickest time rather than the most suitable or economical types of machinery. Consequently we have ships built and building, equipped with propulsive plants that will be very expensive to operate and maintain. The emergency is passing, and the time is in sight when these ships will be operating in the world's trade and competing with the ships of other nations. We are faced with certain shipping laws and wage rates which, added to fixed charges and other operating costs, make it rather difficult to see how this large fleet can be operated at a profit. Already there has been a proposal from high authority to write off one billion dollars from the first cost of the vessels.

While such a write off would unquestionably reduce the paper operating charges, it is somewhat fictitious. Actually it means that the Government and taxpayers accept a one billion dollar loss on their fleet in the beginning. While this proposal may or may not be for the best, it points to the importance of economy in the operation of the fleet. The cost of operation of a fleet of ships consist in general of the following items:

Interest and depreciation;
Administration expenses;
Wages and subsistence;
Fuel and stores.

Any direct saving in wages and fuel, etc., will be really not fictitious. By use of a motive power, which involves a smaller operating crew, the total



Stern view of the 15-knot Diesel-driven motorship "GLENAPP." She is a British war-time production from the shipyard of Barclay Curle, and Diesel engined by Harland & Wolff

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amount of wages paid will be reduced even though the present rate be maintained. By making the fuel consumption one-third of what it is with the present steam installations, there would also be another great saving. *All of this can be done by the use of internal-combustion heavy-oil engines.* Not only can these savings be made, but the earning power of the ships can be increased either by increased speed or by increased cargo capacity, both of which are incident to the use of the oil-engines.

The heavy-oil engine for use in cargo ships has long since passed the experimental stage. Such engines have now been in use for over ten (10) years, which would seem a long enough time to have overcome the prejudice and stubbornness of the ultra-conservative engineers, shipbuilders and shipowners. While this inertia, or conservatism, seems inherent in human nature and appears in force in connection with all new developments in ship propulsion [Probably not disconnected with the huge sum involved with each experiment, which make some shipowners keep off the path of progress—*Editor*], it is believed that an emergency now exists which would fully warrant this country in going ahead with what has been demonstrated to be the most economical method of ship propulsion and operation, which is unquestionably the internal-combustion heavy-oil engine.

The subject is one which has already received a certain amount of investigation and study at the hands of those in authority. But there are certain phases of it which have not been brought out and which should be investigated before any wholesale commitments are made. Up to the present, the most successful ships have been equipped with very large, heavy-duty, Diesel engines, usually installed in pairs on twin screws. The four-cycle type of engine has apparently been the most successful, although there are some good two-cycle sets in operation. These engines, however, are exceedingly heavy and their first cost is enormous. Only one such pair of high-powered heavy marine engines has ever been built in the United States. These were for the U. S. S. "Maumee." Each engine was of the six-cylinder, two-cycle, single-acting type and developed 2,500 horse-power. They were built by the New York Navy Yard, and it is said that they were exceedingly costly. [It is extremely doubtful if engines built by private engineering concerns would cost as much as the engines of the "Maumee." As only a pair were built, instead of a large number, the manufacturing costs were unusually high, not to overlook the fact that they were built in a Navy Yard.—Editor.]

There is no commercial plant in the United States at the present time engaged in the building of marine engines of such large size. To build and equip a new plant suitable for such work would cost millions of dollars. There is, however, a way in which this situation can be met, and American ships can be equipped with American oil engines at first cost not greater than that of the large European engines. The American engines would, however, have to be something entirely different from the European engines and relatively cheaper. To accomplish this we would have to use engines which have already been developed in this country which are of much lighter weight and which run at a higher speed. But in order to use such engines we would also have to use the system known as the electric drive, as such engines could not be connected directly to the propeller of the ship.

The system of electric propulsion is by no means new. It has been tried out in the U. S. Navy with most satisfactory results. In fact, according to a recent newspaper announcement, the Navy Department has recently decided that all of its large battleships hereafter will be equipped with the electric drive. In the case of these vessels, the power is derived from steam through high-speed steam-turbines directly connected with generators. The chain of apparatus in such vessels consists of boilers, the turbines, the generators, and the propelling motors. In the proposed Diesel-engine electric drive this chain can be shortened and consists, namely, of the engine, the generator, and the motor. As compared with the steam-electric drive, the fuel consumption of the Diesel engine installation will be only about one-third of that of the steam plant.

One important question to determine is the size and type of Diesel engine to be used with the electric drive. Since the engine is not connected directly with the propeller, there is a wide range of size and speeds of engines that would serve the purpose. One extreme would be an exceedingly large number of very small engines, running at very high speed and connected to very small generators. The other extreme would be to concentrate all of the power in one engine and to run that engine at the most suitable speed compatible with the design. In between these two extremes there is a size of engine which would be the most economical both from the standpoint of first cost and of operating expense. So far as first cost is concerned there is already available certain data which clearly points to the most suitable size of engine.

There are certain natural physical laws which apply to Diesel engines and which cannot be altogether evaded. One of the elements which determines the power developed by the engine is the piston speed. This is more or less a constant quantity for each class of engines. That is, for stationary slow-speed engines, the piston speed will be about 600 or 700 feet per minute, whether the engine be large or small. For very light-weight high-speed engines, the piston speed has been increased up to 1,200 feet per minute, which is considered about the limit. In between these two speeds certain moderate weight commercial engines have been operating very successfully for years at a piston speed of about 900 feet per minute. It is this speed that is recommended for the Diesel engine to be used in connection with electric drive. It is high enough to get the best results and yet not too high to cause any serious trouble in operation or appreciable decrease in the life of the engine.

Having decided on the piston speed, the next question is to decide on the size and the number of cylinders, stress in material, factors of safety, and so on. The stresses in material, the factors of safety, and so on, have all been accurately determined for various classes of engines and do not differ greatly even in extreme sizes of engines. The heavy-weight, slow-speed engines, as a rule, have lower stress and higher factors of safety than the smaller engines, but by adopting a middle course a very satisfactory engine can be built which will be neither extremely light nor extremely heavy in proportion to its size.

Having thus determined the piston speed and the stresses in material, there then remains only to determine the size of cylinders and the number of cylinders to be put on each engine. Since the piston speed is constant and since the mean-effective-pressure in any engine of the type contemplated is the same, the horse-power output of the engine will vary directly as the square of the cylinder diameter. Since the stresses are to be kept uniform, the weight of the engine will vary directly as the cube of the diameter.

These are natural laws which will be found to hold absolutely true for any one design, whether it be built with a small cylinder diameter or with a large cylinder diameter. Since the weight varies directly with the cube of the diameter and since the power varies only as the square of the diameter, then the weight per horse-power will vary directly with the diameter. That is, for example, if an engine having a 10-in. cylinder weighs 100 lbs. per horse-power, a similar engine having a 20-in. cylinder will weigh 200 lbs. per horse-power. Or, expressed in another way, if we take a big engine having cylinders of 30 in. diameter and weighing 400 lbs. per horse-power, a similar smaller engine having a cylinder of 10 in. diameter would weigh only 133 lbs. per horse-power.

The first cost of an engine is, as everyone knows, made up of two parts; namely, labor and material. It has been found in practice that very small Diesel engines are practically prohibitive on account of the high cost per horse-power. Since the amount of material entering into this engine is relatively small, the high cost of horse-power is due to the labor. At the other end of the scale we have a very large engine, where the weight per horse-power increases enormously and the high cost per horse-power also goes up, in this case due to material. Between these two extremes there is for any given type of engine only one size that will be the most economical to build; that is, it will have the least cost per horse-power.

For one type of engine that has been built in three different sizes, the following relative costs have been decided:

Diameter of Cylinder	Relative Cost Per Horse-Power
4 inch cylinder.....	200 per cent
8 " "	130 per cent
12 " "	110 per cent
15 " "	100 per cent
20 " "	112 per cent
24 " "	130 per cent
30 " "	165 per cent
36 " "	200 per cent

The most economical size of this design then might be said to be between 12 in. and 18 in. diameter. In this connection it is an interesting fact that there is also a certain physical limitation coming in this region. This limitation is in connection with the piston which, with cylinders above 18 in., must be water cooled, thus involving an additional complication and expense. [One well-known European firm of marine Diesel engine builders maintain that it is very advisable to water cool the pistons whenever the diameter exceeds 16 ins.—Editor.]

At the extreme end of the scale there is also another physical limitation which has up to the present not been overcome. This is in regard to the thickness of the cylinder walls. This limitation is placed approximately at a 36-in. diameter, where the walls must be in the neighborhood of 2¼ in. to 2½ in. thick. As soon as the walls reach this thickness a limit has been reached, due to the fact that heat cannot be transmitted through such thick walls at a sufficient rate. This limitation has been actually encountered in some of the largest engines which have been built for experimental purposes. [Sulzer Freres have experimented with a 40 in. dia. cylinder—*Editor.*] So, for the exceedingly large engine, there appears to be both a physical limitation due to heat conditions and a commercial limitation due to excessive weight and prohibitive costs. Expressed in another way, an engine can be built with cylinders from 15 to 18 in. diameter, the cost of which will be approximately half that of the very large unit or of the very small unit.

For the reasons above given, the limiting size of the four-cycle, single-acting engine may be considered to be about 500 brake-horse-power per cylinder. If six-cylinder engines were used, one on each shaft, this puts the limit of 3,000 horse-power per shaft, or 6,000 horse-power per ship, where twin screws are used. [We can expect two-cycle Diesel engined motorships developing 4,000 I.H.P. per shaft from four cylinders in the very near future. Probably early next year. With six-cylinder engines this would mean 12,000 I.H.P. in the case of a twin-screw ship—*Editor.*] For certain purposes, such as the propulsion of battleships, moderate and high speed passenger ships, such horse-power is altogether inadequate. When, however, the electric drive is used, it is quite possible to install the total horse-power required. By adding the cost of the electric equipment to the cost of engines, the cost per horse-power of the electric drive will be decidedly less than in the case of the big direct drive units.

One way in which to regard the proposed system of propulsion is to consider that the engines and electric generators take the place of the boilers of the steamship, and that the electric propelling motor takes the place of the steam engine. For very large power certainly no one ever objected to a multiplicity of boiler units. For the same reason no one should logically object to the multiplicity of engine units. As a matter of fact, the engines have now been developed to a point where they would require less care and attention than the boilers during operation where their life is as long or longer than boilers and where costs and repairs would be no greater.

One would not, of course, deliberately install an excessive number of units in any plant. One could, however, very reasonably carry the same number of engine units as are now carried in boiler units. That is to say, some ships might have one or two engines, where they now have one or two boilers, and other ships might carry ten or twelve, as the case might be, all depending on the amount of power required. There could also be a difference in the size of the engines within certain reasonable limits, based on investigations at first cost and operating expense.

By keeping the engine within moderate dimensions, say cylinders from 16 in. to 18 in. in diameter, the parts are relatively light and small. With all of the cylinders being of the same size the total cost and weight of an ample supply of spare parts would be comparatively small. When adjustments and repairs are required, as they will be in all engines, they can be made by the ship's force at sea or at almost any port in the world.

Fortunately there are a number of Diesel engine builders in the United States already equipped to build engines of approximately the size required. There are also manufacturers of electric equipment in a position to go ahead and furnish and guarantee generators and motors. The combined weight of the engine and electric equipment will be approximately half that of the weight of the direct-connected slow-speed engine, and the combined cost will be approximately seventy-five per cent of the cost of the slow-speed, heavy duty engine.

There is, of course, a certain loss of power in the electric transmission through the generators and motors. Part of this loss is made up by increase of propulsive efficiency when comparing a twin-screw direct drive with the single-screw electric drive. This is due to the resistance of the struts on the twin screw installation. The remaining loss is only slight and is many times compensated for by all the other savings above mentioned.

Another great advantage of the electric drive is its flexibility. When a ship is being driven against a head-sea, the extra resistance encountered reduces her speed. In a steam plant there is a certain amount of flexibility. The power developed in the boilers can be utilized by increasing the

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amount of steam admitted to the cylinders, thereby increasing the mean-effective-pressure developed in the cylinders. But in the direct-connected Diesel engine there is not so much flexibility because the mean-effective-pressure developed in the engine cannot be increased to the same extent that it can in the steam engine. With the electric drive, however, we can overload the motor, to a certain extent, and thus utilize the output of the generators at reduced speed of the ship and reduced revolutions of the propellers.

As in most cases of this kind, there are advantages and disadvantages peculiar to the two types of machinery under comparison. This article is not intended to cast any reflections on the large, heavy-duty, slow-speed Diesel marine engine, which is giving a splendid account of itself, but, it seems important at this time to point out some of the advantages of the electric-drive combination. While always remembering the somewhat less over-all efficiency of the electric drive, which has many advantages, the greatest reason for its adoption is its immediate availability.

It is true, of course, that there are European competitors who can avail themselves of this system. But if we are the first to adopt it and equip some of our ships now building with this ideal propulsive plant, we shall obtain a lead which will take them a long time to overcome. But to do this we must act now and not wait for another ten years in deference to so-called "conservatism." Some of our national merchant-marine ships can be equipped with the electric drive and can be in operation probably a year sooner than some other ships fitted with the heavy-duty engine. So much is now known about both systems that there seems little excuse to listen to so-called conservatism. What we very urgently need is a merchant marine that can be operated at a profit in competition with the rest of the world, and we want it soon. Therefore let us have this economical merchant marine without delay! [Our columns are open to further discussions on this subject.—Editor.]

G. C. DAVISON.

The Adaptability of the Motorship to Higher Standard Cargo-Ship Speeds

By J. C. SHAW

(of the Wm. Cramp & Sons Ship & Engine Co., Philadephia, Pa.)

A COMPARATIVE study of the new motorship "Bullaren," described in January number of "Motorship," with similar size motorships, but of less speed, brings out the peculiar adaptability of the Diesel-driven vessel to higher speeds than heretofore considered standard for similar steam vessels. This is due to the inherent high economy of the Diesel engine, the increased cost at which the additional speed is purchased being small compared with the increased revenue and as otherwise would be the case with steam.

The sister motorships referred to are the "Chile," "Peru," "George Washington," etc., descriptions and performances of which have been published in previous issues of "Motorship." These have the same length B.P. as the "Bullaren" and the same normal deadweight capacities, implying similar cargo capacities. The "Bullaren" has slightly more beam, which probably compensates for its slightly extra weight in machinery.

As to first cost, the "Bullaren" should not exceed the similar vessels by $100,000, if built under similar conditions, which expressed in terms of interest on the extra investment is about $5,000 per year, and almost negligible.

When the "Bullaren" has her temporary cast-steel propellers replaced by machined bronze ones she should show a speed in service of 12 to 12.25 knots, or a knot and one-quarter better than the lower-powered similar vessels. The oil consumption at sea will be about 25% more than the slower ships, although the designed power is 28% more, this discrepancy in percentages being mostly explained by the fact that the auxiliaries are practically identical for either type of ship. The slightly higher consumption of lubricating-oil for the larger main engines is about balanced by the less number of days at sea.

From a personnel standpoint there will be no increased cost in operation for the "Bullaren," as the staff in the engine-room should be identical as to number of men and rating. Also what difference in upkeep there may be, due to the larger engines, can be considered negligible.

Taking voyages or round trips of 8,000 miles as a basis, with 14 days total in ports per voyage, and the service speed of the "Bullaren" as 12 knots, and the lower powered vessels as 10.75 knots, with their fuel-consumptions per day as 12.5 and 10 tons respectively, the following comparison can be made on a yearly basis:

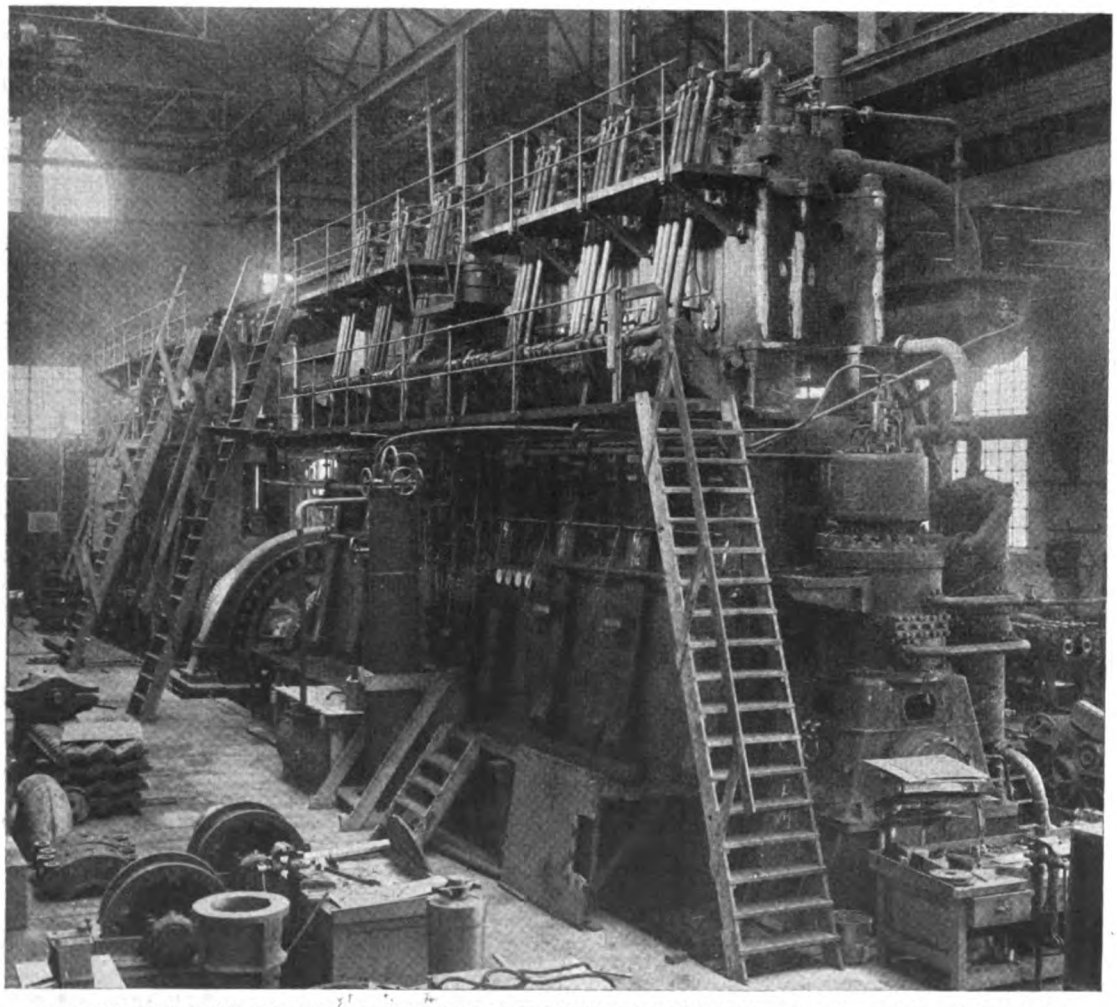
	"Bullaren"	"Chile," Etc.
Number of days at sea	242	252
Number of days in port	123	113
Oil burned at sea, tons	3,025	2,520
Oil burned in port, tons	65	60
Total oil burned, tons	3,090	2,580
Total mileage in knots	70,000	65,000
Number of round trips	8.75	8.125

It will be seen from the above that the "Bullaren" makes five-eighths more of a round trip per year, consumes 510 tons more oil and, due to her greater mileage, carries an equivalent of 11,250 tons more cargo one way with 9,000 tons cargo capacity as basis. With oil at six cents per gallon, or $13.50 per ton, and a freight rate of $10.00 per ton for the 4,000 mile shipment, which may be taken as reasonable figures, the increased net earning capacity is, in round numbers, about $100,000 for the faster boat. This would pay off in one year's time the extra first cost of the vessel, and afterward would become extra profit.

Another factor in favor of the higher speed vessel, which does not appear in the above comparison, is the preference of shippers to ship by the faster line, making towards fuller cargoes. Also this class of vessel usually has accommodations for a few passengers who would likewise favor a faster ship.

The speed of the "Bullaren" is not to be taken as the limit of desirable speed for the motorship which must be determined by the particular service and conditions for which the vessel is intended.

With steam-driven cargo-boats the speed quickly becomes a limiting factor due to the larger increased cost in fuel entailed and much greater space required for fuel compared with motorship.



The two 2,000 I.H.P. Diesel-type oil-engines of m.s."BULLAREN" in the test-shop at the Gota Works. Note the electric generator used as a brake for testing the motors. Two engines of similar size and design have been purchased by the U. S. Shipping Board from Burmeister & Wain, of Copenhagen

THE CYLINDER DIMENSIONS OF THE M.S. "BULLAREN" AND M.S. "GLENAPP"

Lloyd's Register of Shipping gives the cylinder dimensions of the M.S. "Bullaren" as 29⅛ in. by 43 5/16 in., and those of the M.S. "Glenapp" as 29½ in. by 43 5/16 in. Our information (obtained from the engineers of the ships) is that the dimensions are 29.1339 in. by 43.3071 in., and 29.921 in. by 43.307 in., respectively. The U. S. Emergency Fleet Corp'n's engineer was told that the diameter was 850 mm. (33.07 in.)

THE MOTORSHIP "GLENAPP"

In our recent description of the British motorship "Glenapp," published in our February issue, the diameter of the crank-pin was given as 14 inches, but we think that about 18 inches probably is the actual size of the crank.

LARGE WINTON DIESEL ENGINE

Now in the early stages of construction at the Winton Engine Works are two marine cross-head type Diesel engines of 1,250 b.h.p. at 130 R.P.M. which will be installed in a steel motorship. These are the first marine type Diesel engines of this power to have commenced construction in the United States.

OIL ENGINES NEEDED

It is reported that the wooden schooner "John W. Wells," recently purchased by the Gulf Mail Steamship Co. from Chas. R. McCormick & Co. of San Francisco, may be equipped with two 500 b.h.p. oil-engines.

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Valuable Test Reports of Merchant-Ship Type Diesel Engines

Final Official Trials of Two White 1200 I.H.P. (750 b.h.p.) Diesel Motors on Texas Crude-Oil

(By Special Permission of the British Admiralty)

READERS of "Motorship" will remember that in our special Naval Number of June, 1918, we published some illustrations and extracts from the test reports of heavy-duty and naval types of Diesel engines built by J. Samuel White & Co. for the British Admiralty. Since that time other engines have been built; but we are enabled to publish the confidential and complete tests of the same engines by kind permission of the British Admiralty, and through the courtesy of the builders of the engines.

The reports of three distinct sizes of engines have been furnished us, and such detail test data has never before been published, so the figures given will be highly valuable to American and other oil-engine builders. The first test that we publish is of White 750 b.h.p. merchant type Diesel engines of the direct-reversible, single-acting, stepped-piston, two-cycle class, with six-cylinder 14½" bore, by 24" stroke, and having a weight complete of about 70¼ long tons. The speed is rather high for merchant-vessels; but 850 b.h.p. was maintained for two hours during the initial tests. We doubt if any Navy Department or Diesel engine builder has previously allowed such detailed information to appear in the press. We give the official report as follows:

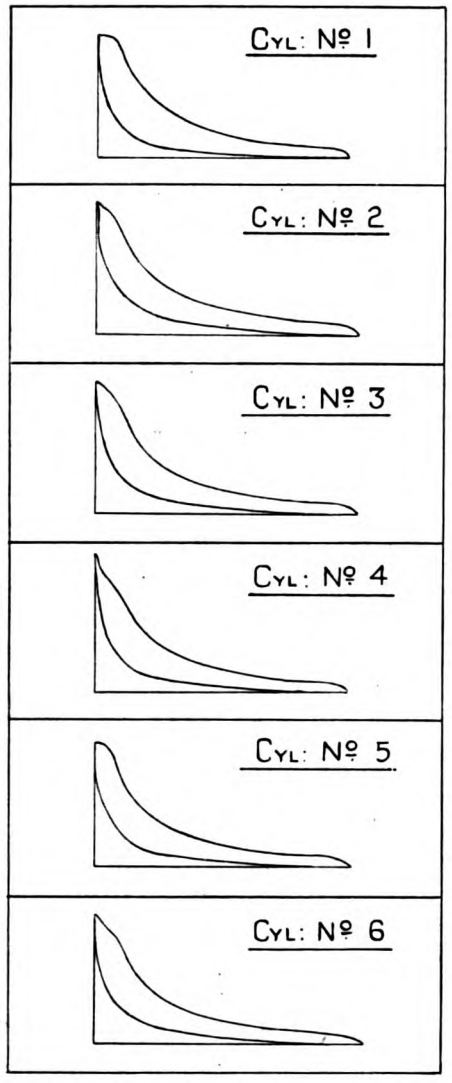
Final Official Trials of the Port and Starboard Two-Cycle "White-Diesel" Oil Engines
(Confidential)

The following report is based on actual results and observations taken during the above official trials.

The trials were carried out in accordance with the specified requirements of the Naval Authorities, and in the presence of their representatives. The power measurements were obtained by means of a Heenan & Froude, 7.D., dynamometer brake.

All the readings then taken during the full power trials of both engines have been arranged in graphic form on the attached curve charts which are constructed from the Official Trial Report Sheets. Both engines ran quietly and steadily throughout their trials, and the vibration was nil. The exhaust gases were **absolutely invisible.**

The Exhaust Silencer used was the same as will be fitted in the ship, and the outlet to atmosphere was practically noiseless. The temperatures of the cooling water, lubricating oil cooling, and of all working parts were steady and normal throughout the trials. After the trials, all valves and valve seats were thoroughly inspected, and were found to be free of any abrasions or pitting.



Indicator diagrams (starboard engine) taken during the latter end of the 96 hours trial

96 Hour Trial
Starboard Engine
Summary of Results

Mean B.H.P.	751.8
Mean Revs. per minute	190.5
Mean I.H.P.	1215.6
Mechanical efficiency	61.84%
Total Revs. for 96 hours	1,097,307
Total lbs. of fuel oil used during 96 hours	35,205 lbs.
Fuel per B.H.P. per hour	0.487
Total lubricating and Cooling oil used for 96 hours	887.7 lbs.
Mean lubricating and cooling oil per B.H.P. per hour	0.0123
Mean temperature of cooling water, inlet	61.5° F.
Mean temperature of cooling water, outlet	99.5° F.
Mean temperature of piston oil cooling, inlet	90° F.
Mean temperature of piston oil cooling, outlet	125° F.
Atmospheric temperature of test shop	61.5° F.
Injection air pressure (mean)	1000 lbs. sq. in.
Scavenge air pressure (mean)	7 lbs. sq. in.
Air Compressors—	
I.P. air cooler pressure (mean)	127 lbs. sq. in.
L. P. air cooler pressure (mean)	27 lbs. sq. in.
Circulating cooling water pressure (mean)	5 lbs. sq. in.
Piston cooling and lubricating oil pressure (mean)	25 lbs. sq. in.
Mean I.H.P. of air compressors	61.56
Compressor suction open	5.35% of total
Mean indicated pressure of No. 1 cylinder	110 lbs. sq. in.
Mean indicated pressure of No. 2 cylinder	106.7 lbs. sq. in.
Mean indicated pressure of No. 3 cylinder	108.4 lbs. sq. in.
Mean indicated pressure of No. 4 cylinder	103.4 lbs. sq. in.
Mean indicated pressure of No. 5 cylinder	117.0 lbs. sq. in.
Mean indicated pressure of No. 6 cylinder	102.5 lbs. sq. in.

Blast air used per B.H.P. = .22 cubic foot.

STARBOARD ENGINE
96 Hour Trial

The official trials of the 750 B.H.P., 2 Cycle, Directly Reversible "White-Diesel" Oil Engine, were carried out in the Works of J. Samuel White & Company, Limited, in the presence of the Admiralty Inspector. The trials of the first engine were to consist of 96 hours' uninterrupted running at the full load of 750 B.H.P., at about 200 revolutions per minute.

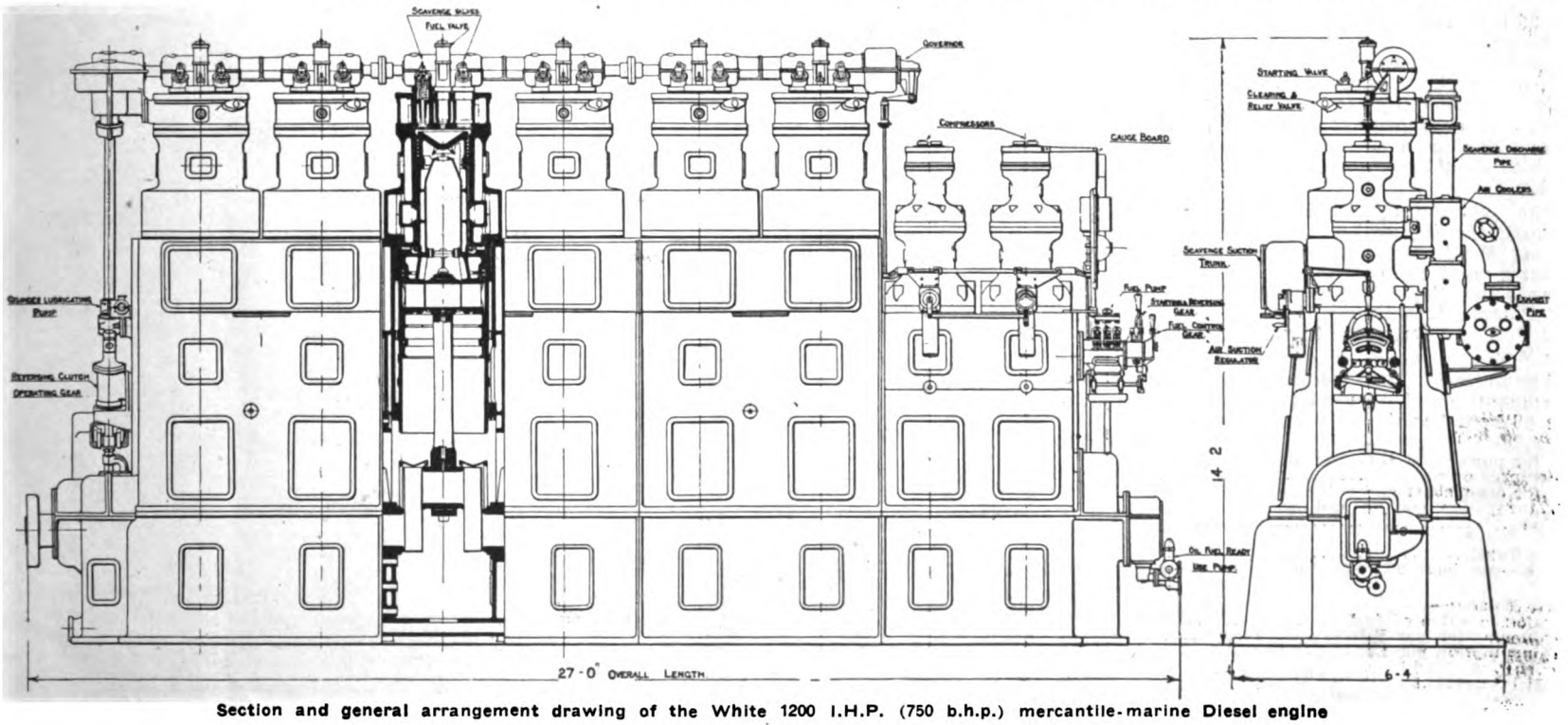
Prior to this a preliminary unofficial trial of 6 hours uninterrupted running took place on the 27th November. This proved to be quite satisfactory, and after one or two adjustments, the engine was ready for the 96 hours' trial.

At 10-15 a. m., 1st December, the engine was started up promptly from cold, and was running on fuel 12 seconds after engine commenced to run on starting air.

At 10.30 a. m., 1st December, the official full load trial of 750 B.H.P., was commenced, with an engine speed of 190 Revolutions per minute.

The Fuel used was Texas Crude-Oil, tested as per the following specifications:

Specific gravity	0.905
Flash point (close test)	218° F.
Flash point (open test)	238° F.
Fire test	286° F.
Viscosity at 32° F., by Redwood No. 2 (Admiralty type) viscometer	420 seconds
Viscosity at 100° F. (Redwood No. 1)	144 seconds
Water	0.3%



Section and general arrangement drawing of the White 1200 I.H.P. (750 b.h.p.) mercantile-marine Diesel engine

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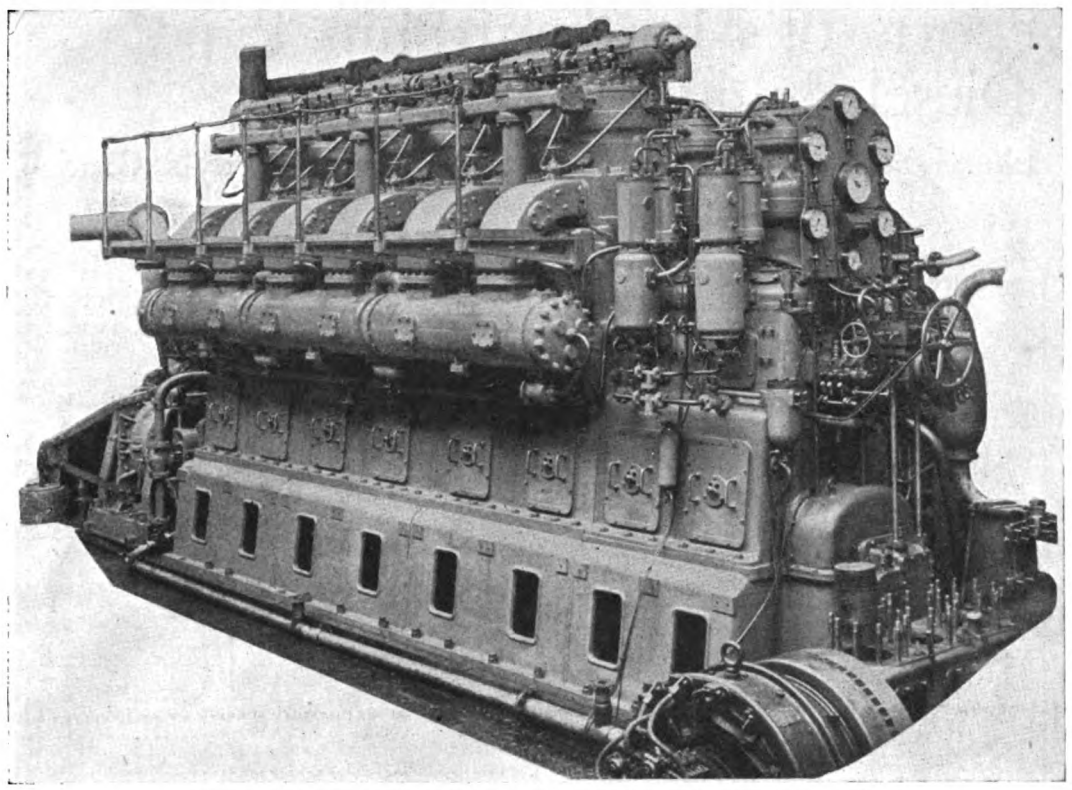

The White 1200 I.H.P. (750 b.h.p.) heavy-duty Diesel marine engine

Sulphur 0.41%
Free acid .....Nil
Calorific value...10840 calories per gram = 19,510 B.T.U.

During the whole 96 hours' trial, the engine ran satisfactorily, and quietly, without any stoppage, and without any signs of overheating either in the cooling systems or working parts. The exhaust was quite invisible, and after the completion of the trial very little soot was observed in the Exhaust branches or Cylinder Exhaust Parts.

It was proved that the engine did not require any vigilant attention; this remark applies particularly to the starting and reversing gear which was not touched during the whole trial. The chief duty of those in attendance was to see to the external lubrication of the engine, and occasionally by means of a special key turn the fuel valve needles on their seats.

At 10.30 a. m., on December 5th, the 96 hours' trial was brought to a conclusion, and the temperatures at the end were practically the same as those at the end of the first hour. Starting and Reversing trials were not carried out on this Engine, but such tests together with the tests of the Emergency Governor, were made during the preliminary tuning up runs. The Emergency Governor was observed to cut out at 230 revs. per minute, and when the engine was running light, the speed variation was between 195 and 220 r.p.m. After the trial, all parts of the engine were dismantled. Indicator diagrams were taken from the Three-Stage Air Compressors at intervals during the 96 hour trial, and it was ascertained that only 0.22 cubic feet of free air per B.H.P. was used for Injection-Air Purposes during the trial. The position of the air Compressor Suction regulator was only open about 1/20 of its total during the whole trial, thus showing that the Compressor Capacity of one Engine is more than adequate to run both engines should one set of Compressors be out of action.

The circulating cooling-water was passed through the engine by means of "Hall's" Direct Acting Vertical Steam Pumps; the quantity of water passed through the engine per B.H.P. per hour being about 11.2 gallons. The Lubricating Oil Pump, which is used both for Piston Cooling and Forced Lubrication is of a similar pattern to the Water-Pump.

The following figures denote as near as possible, the quantities of oil used for all purposes during the 96 hours' trial:

	Lbs.	Ozs.
Oil for power and scavenge pistons and L.P. compressor pistons	80	0
Oil for crankshaft and valve gearing	112	0
Oil for piston cooling and bearing lubrication	693	0
Total	885	0

1. e.—per hour 9.22 lbs. (or per B.H.P. per hour) = 0.0123 lbs.

Heat Balance—
Calorific value of fuel.....19510 B.T.U.
Consumption per B.H.P. per hour.....0.487 lbs.
Consumption per I.H.P. per hour.....0.303 lbs.
B.H.P. = 751.8 } Mech. efficiency = ...61.84%
I.H.P. = 1215.6 }

1. B.H.P. hour = $\frac{33000 \times 60}{778.}$ =.....2550 B.T.U.

1. B.H.P. requires 1.62 I.H.P., therefore
frictional heat per B.H.P. = ...0.621. I.H.P.
= $\frac{.627 \times 33000}{778.} \times 60$ = ...1578 B.T.U.
Heat taken in per B.H.P. per hour
= 19510 × .487 = ...9500 B.T.U.
I.H.P. heat units per B.H.P.
= $\frac{1.62 \times 33000}{778.} \times 60$ = ...4120 B.T.U.

Heat, converted into work on brake.	2550	26.9	43.5
Heat, lost in engine friction.....	1578	16.6	
Heat, converted into indicated work	4120	43.5	100%
Heat, lost in cooling water.....	2480	26.1	
Heat, lost in exhaust gases.....	2900	30.4	
Heat, taken in per B.H.P. per hour.	9500	100.0	

Thermal efficiency of engine = 26.9%

48 Hour Trial
Port Engine
Summary of Results

Mean B.H.P.....756.47
Mean Revs. per min.....181.19
Mean I.H.P.....1154.85
Mechanical efficiency 65.5%
Total Revs. for 48 hours.....521.834
Total lbs. of fuel oil used during 48 hours....16,986 lbs.
Fuel per B.H.P. per hour.....0.467 lbs
Total lubricating and cooling oil used during 48 hours .....459.8 lbs.
Mean lubricating and cooling oil per B.H.P. per hour .....0.0125 lbs.
Mean temperature of cooling water inlet.....63° F.
Mean temperature of cooling water outlet.....100° F.
Mean temperature of piston oil cooling inlet.....92° F.
Mean temperature of piston oil cooling outlet...123° F.
Atmospheric temperature of engine-room.....62° F.
Injection-air pressure (mean).....960 lbs. sq. in.
Scavenge-air pressure (mean).....6.5 lbs. sq. in.
Air Compressors—
I.P. air cooler pressure (mean).....125 lbs. sq. in.
L.P. air cooler pressure (mean).....25 lbs. sq. in.
Circulating water pressure (mean).....5 lbs. sq. in.
Piston cooling and lubricating-oil pressure (mean) .....25 lbs. sq. in.
Mean I.H.P. of air-compressors.....65.4
Compressor suction open 7.14% of total.
Mean indicated pressure of No. 1 cylinder .....98.4 lbs. sq. in.
Mean indicated pressure of No. 2 cylinder .....105.3 lbs. sq. in.
Mean indicated pressure of No. 3 cylinder .....101.3 lbs. sq. in.
Mean indicated pressure of No. 4 cylinder .....110.8 lbs. sq. in.
Mean indicated pressure of No. 5 cylinder .....109.7 lbs. sq. in.
Mean indicated pressure of No. 6 cylinder .....109.0 lbs. sq. in.
Blast air used per B.H.P. = .234 cubic feet.

PORT ENGINE
48 Hour Trial

The official trials of this Engine were carried out on a similar basis to those of the Starboard Engine. The hours of duration of Full Load trial were to be 48, followed by manoeuvring trials, which consisted of astern running, time taken to pump up the starting reservoirs, slow speed running, and the drop in pressure of the starting air after each start.

Prior to the 48 hour trial a preliminary unofficial trial of 8 hours' uninterrupted running took place on the 5th January. This trial proved to be satisfactory in every respect. At 10.15 a. m., on the 7th January, the engine was started up promptly from cold, and was running on fuel 10 seconds after engine commenced to run on starting air.

At 10.30 a. m. the official full load trial was commenced and the average B.H.P. for the 48 hours' running was 756.47 at 181 r.p.m. The fuel used was Texas Crude-Oil of the same grade and specification as used for the Starboard Engine, with a Calorific Value of 19510 B. T. U. The general characteristics of this engine were similar to those of the Starboard Engine. The exhaust again was quite invisible; the engine ran quietly and smoothly without any stoppage, and very little attention was required. At 10.30 a. m., on January 9th, the 48 hour trial was concluded, and the temperatures as will be seen from the graphical chart were quite normal at the end of the trial. Without stopping the engine, the manoeuvring and slow speed trials were commenced, running the engine at the least possible number of revolutions, consistent with the satisfactory running of the engine.

The results obtained were as follows:

1. All six cylinders firing.
Lowest speed with engine running smoothly, 65 Revs.

2. With three cylinders firing.
Lowest speed with engine running smoothly, 55 Revs.

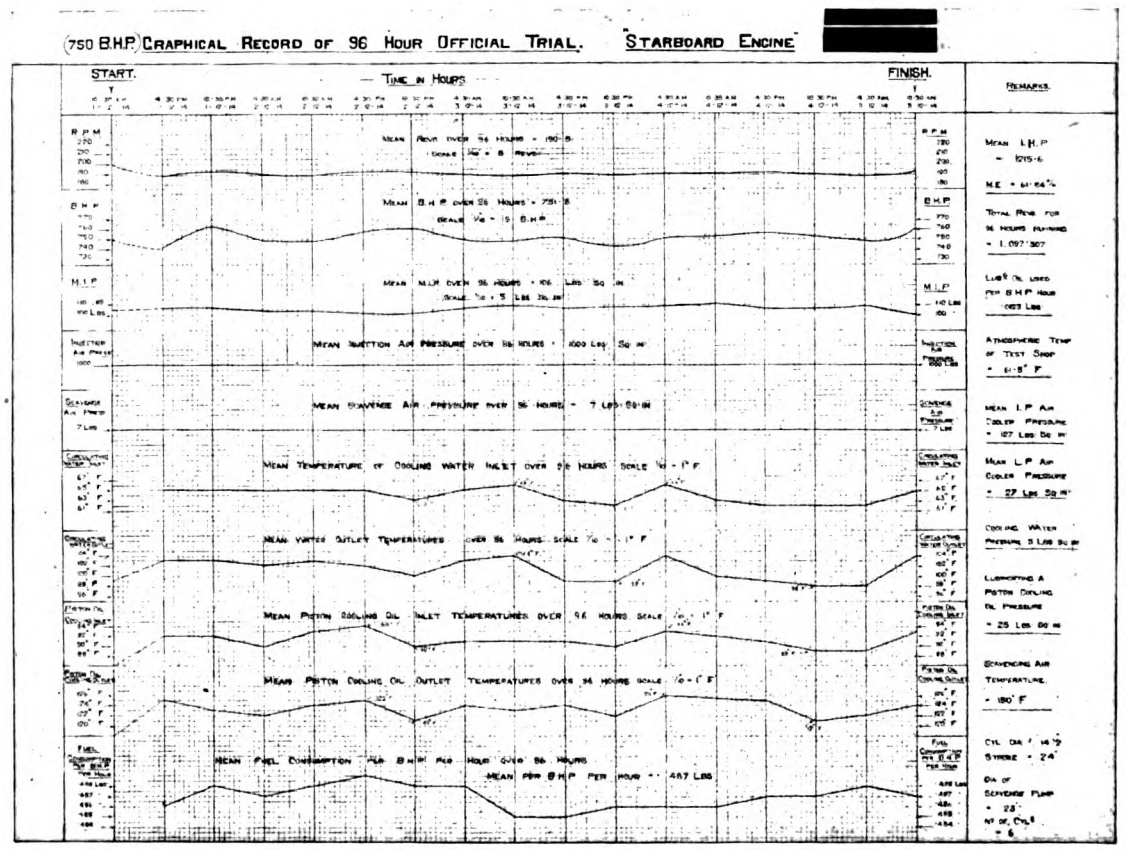

Chart of 96 hour test of White merchant-type marine Diesel engine

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At the point a reversing manoeuvre was successfully carried out. The engine running astern at the low speeds just as consistently as when running ahead. After the above the engine was stopped and started to ascertain the exact number of starts which would be obtained from the starting reservoirs.

No. of Manoeuvre	—Starting Pressure— Before	After Manoeuvre	
1	800 lbs.	760 lbs.	
2	760 "	720 "	
3	720 "	675 "	
4	675 "	630 "	
5	630 "	580 "	No. of
6	580 "	525 "	
7	525 "	480 "	starting
8	480 "	430 "	
9	430 "	387 "	reservoirs, 5.
10	387 "	325 "	
11	325 "	298 "	Capacity of
12	298 "	245 "	
13	245 "	216 "	total, 42.5 c.f.
14	216 "	187 "	
15	187 "	173 "	
16	173 "	150 "	
17	150 "	144 "	
18	144 "	Engine refused to start	

The above manoeuvering trials were carried out in moderately quick succession. All seventeen manoeuvers were gone through within a period of 25 minutes, this time included so many minutes run on fuel in the ahead or astern direction. Actually the average time taken, from stop to start, and running on fuel, was about 25 seconds.

The lowest pressure at which engine would start was 150 lbs. sq. in. The starting installation on board ship will consist of five air reservoirs, whose total capacity is 42.5 cubic feet. Four of these will be charged to 1000 lbs. per sq. in., and interposed between these and the fifth bottle will be a reducing valve, set to reduce from a 1000 lbs. per sq. in. to 650 lbs. per sq. in. Thus all the air for starting purpose has to pass through the fifth reservoir at the lower pressure; by this system a greater number of starts can be carried out, and in this case as many as 30 starts could be made.

Shortly after the starting and stopping trials the engine was got underway again, and speeded up to 220 revs. per minute. The Air Compressor Suction Throttles were opened to their maximum and the time ascertained to charge the 5 starting reservoirs. The actual time taken to charge up the reservoirs from 150 to 600 lbs. per sq. in. was 6 min. 50 secs. During this period the engine developed about 920 B.H.P. with a blast pressure of 1050 lbs. sq. in. After this the engine was shut down, and shortly afterwards dismantled, and all working parts were found to be in excellent order.

The Air Compressors during the 48 hour trial worked with the suctions throttled to about 1/14th of their maximum. The quantity of air used for injection purposes was 0.234 cubic feet per B.H.P. This is slightly higher than the Starboard Engine, due to the slower speed of the Engine. The circulating water and forced lubrication pumps were similar to those of the Starboard Engine.

The following figures give as near as possible the quantities of Lubricating and Cooling Oil used during the 48-Hour Trial:

	Lbs.	Ozs.
Oil for power and scavenge pistons and L.P. compressor pistons	42	2
Oil for camshaft and valve gearing	61	8
Oil for piston cooling and crankshaft bearing lubrication	356	0
Total	459	10

i. e., per hour 9.58 lbs. (or per B.H.P. per hour) = .0125 lbs.

The quantity of water passed through the engine was not measured during the 48-hour trial of the Port Engine.

Heat Balance

Calorific value of fuel.....19510 B.T.U.
Consumption per B.H.P. per hour.....0.467 lbs.
Consumption per I.H.P. per hour.....0.309 lbs.
B.H.P. = 750, I.H.P. = 1145 } Mechanical efficiency = ...65.5%

$$1.\ \text{B.H.P. hour} = \frac{33000 \times 60}{778.} = \ldots\ldots\ldots 2550\ \text{B.T.U.}$$

1. B.H.P. requires 1.527 I.H.P.
Frictional heat per B.H.P. = ...0.527

$$\therefore \frac{0.527 \times 33000}{778.} \times 60 = \ldots\ldots\ldots 1340\ \text{B.T.U.}$$

Heat taken in per B.H.P. per hour =
19510 × .467 = ...9130 B.T.U.
I.H.P. heat units per B.H.P

$$= \frac{1.527 \times 33000}{778.} \times 60 = \ldots\ldots\ldots 3890\ \text{B.T.U.}$$

	B.T.U per B.H.P. Hour	Percentage	
Heat converted into work on brake.	2550	27.9	42.6%
Heat lost in engine friction.....	1340	14.7	
Heat converted into indicated work.	3890	42.67	100%
Heat lost in cooling water.....	2390	26.2	
Heat lost in exhaust gases.....	2850	31.2	
Heat taken in per B.H.P. per hour.	9130	100.0	

$$\text{Thermal efficiency of engine} = \frac{2550}{9130} \times 100 = \ldots\ldots 27.9\%$$

RUNNING OF ENGINES ON BOARD PRIOR TO AND DURING OFFICIAL TRIALS AT SEA

NOTES ON WORKING OF MAIN AND AUXILIARY ENGINES DURING TRIP FROM TYNEMOUTH TO SHEERNESS

TRIALS AFTER ARRIVAL AT SHEERNESS
First Trials. 3—8—15

The auxiliary Diesel flasks were charged up to 600 lbs. pressure by the steam compressor. The auxiliary Diesel compressor was got away on paraffin in the afternoon, but was shut down owing to an air lock when changing over from paraffin to crude oil.

4—8—15. Auxiliary Diesel Compressor ran during the afternoon and charged up all main engine starting flasks. Port engine was run on air during the afternoon, but failed to pick up on fuel due to a leakage in the air injection system, this having dropped to 200 lbs. pressure; starting flasks were again charged up by auxiliary Diesel compressor.

5—8—15. Port engine got underway at 10.15 a. m. and ran for 25 minutes at 130 revolutions; had to be shut down to remedy air lock in No. 6 cylinder.

6—8—15. Starboard engine was run in the forenoon on crude oil for 20 minutes; engine shut down to replace broken scavenge valve casing. Port engine was run shortly afterwards for 20 minutes, but was shut down owing to fuel valve sticking open.

RUNNING OF ENGINES ON BOARD PRIOR TO AND DURING OFFICIALS AT SEA

10—8—15. Auxiliary Diesel compressor started up at 10.30 a. m., but was shut down due to failure of lubricating oil. Port engine started at 4.20 p. m. had to shut down after running a few minutes owing to No. 6 starting valve sticking open. Port engine was got away again at 5.30 p. m. and ran well for 65 minutes. Starboard engine was also started, but had to be shut down, due to scavenge valve sticking open.

20—8—15. Port engine got away promptly at 10.10 a. m. and charged up all flasks. After this run the compressors were stripped, and No. 2 H.P. piston was found to be fractured; this was replaced by spare. Starboard engine started promptly at 11.25 a. m. and run well for 65 minutes.

18—8—15. Auxiliary Diesel compressor was started up at 10.30 a. m., but had to be closed down owing to failure of lubricating oil.

19—8—15. Auxiliary Diesel compressor got away at 10.20 a. m. and charged up all main starting flasks.

20—8—15. Port engine got away promptly at 10.10 a. m., but had to be shut down after running for 15 minutes, due to failure of Mollerup's lubricators on air-compressor. After this the engine ran for 15 minutes ahead and 15 minutes astern.

20—8—15. Starboard engine was started at 12.20 p. m. and ran for 20 minutes, and then reversed and ran astern for a few minutes.

23—8—15. Port engine was got underway at 2.55 p. m., but was stopped after running a few minutes, owing to a leaky pipe joint on H.P. compressor. The engine was started again shortly afterwards and ran for about 2 hours, handled by ship's company, being stopped, started, and reversed several times.

24—8—15. Starboard engine was got underway at 2.40 p. m., but had to be shut down after 15 minutes' run to remedy loose turning wheel. Afterwards the engine was run for two hours by the ship's company, being stopped, started and reversed several times.

No further runs were made before the trials.

SEA-GOING TRIALS
First Trial. 26—8—15

Ship was swung into river, and starboard engine was started at 7.20 a. m.; was shut down at 7.27 owing to No. 2 fuel valve sticking open. Ship was swung for adjusting compasses, after being towed inside breakwater at mouth of river. Ship was towed out through breakwater at 11.30 a. m. and port engine was rung down at 11.43 a. m., but refused to start owing to No. 6 starting valve sticking open.

Starboard engine was rung down at 11.45 a. m. and started promptly. Stopped again at 12.30 p. m. through trouble with cylinder clearing valves. Port engine was started at 1.18 p. m. and was started and stopped several times during gun trials. No. 6 power cylinder port engine cracked water jacket at 2.30 p. m. Fuel was cut off this cylinder and revolutions reduced. Both engines were stopped at 6.30 p. m. after running on and off for about four hours.

27—8—15. Spare cylinder was fitted in place of the cracked one on port engine and all valves were examined and little faults through bad fitting rectified.

28—8—15. SECOND TRIAL

Both engines were rung down at 12.25 p. m. Starboard engine refused to start, due to insufficient priming. Port engine started promptly, but had to be shut down due to flanges of injection pipe shearing. The pipe was repaired, and port engine got away at 2.25 p. m. and ran until 3.50 p. m., when No. 6 starting valve gave trouble. During an attempt to start the starboard engine at 4.15 p. m. an explosion occurred in No. 1 fuel valve and fractured the cover. The ship was then towed back to moorings.

29—8—15. New cylinder cover was fitted on starboard engine, also new fuel valve. Valves in starting heads were examined.

30—8—15. Starboard engine was started at 4.5 p. m. and had to be shut down owing to copper safety disc blowing out on injection pipe. Port engine was got away at 4.8 p. m. and closed down at 7 p. m. Starboard engine was got away at 4.18 p. m. and had to be shut down at 4.25 p. m., due to turning wheel becoming loose.

31—8—15. FINAL AND ACCEPTANCE TRIAL

Ship left jetty at 12.15 p. m. for official trials. Both engines were got away at 12.20 p. m.

Trial started at 1.20 p. m. Trial concluded at 4.20 p. m.

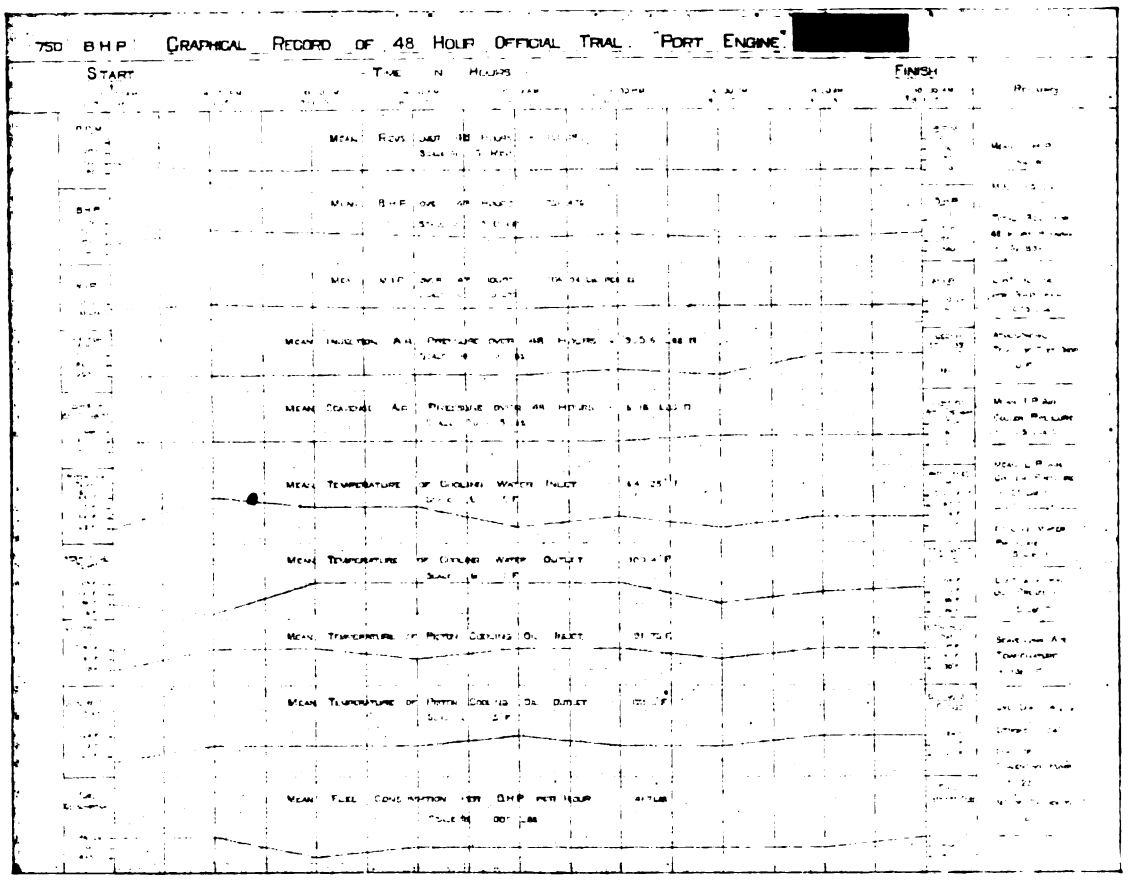

Chart of 48 hour test of White merchant-type marine Diesel engine

Both engines were manoeuvred from 4.25 p. m. to 4.45 p. m. During the whole time they ran quietly and steadily and without vibration. The exhaust throughout any of the aforementioned trials was colorless.

NOTES ON WORKING OF MAIN AND AUXILIARY ENGINES DURING TRIP FROM TYNEMOUTH TO SHEERNESS

Left Tynemouth, Tuesday, August 31, 1915, at 6.30 p. m.

Arrived at the Nore, Thursday, September 2, 1915, at 11.45 p. m.

Tuesday, August 31, 6.30 p. m.—Both engines half-ahead, and then full speed, running all right except for slight leakage on one or two clearing valves.

Note:—Replaced old sight-feed lubricators on compressors, as the new mechanically operated pumps refused to work. This was done on main engines only, soon after we left. The pump on auxiliary engine (571) worked quite well.

Mid-night.—Full speed astern both engines. The order was obeyed promptly and both came astern for say two-thirds minute, and then telegraph came to stop. Next order given was half-ahead. Ran for five minutes and again both astern. Engines were then stopped as steering engine was out of action.

1 a. m.—Steam air-compressors were got underway both in engine room and in auxiliary machinery room.

Starting air replenished.

Steering engine overhauled by artificers and put right.

(Valve found jammed).

Port engine away running O. K.

In starting up starboard engine (Chief E. R. A. in charge) it was noticed that clearing valve on No. 5 cylinder was blowing very badly. Decided to stop this engine. The valve was taken out and found to be quite burnt away. Decided to blank off this cylinder, and carried out job forthwith.

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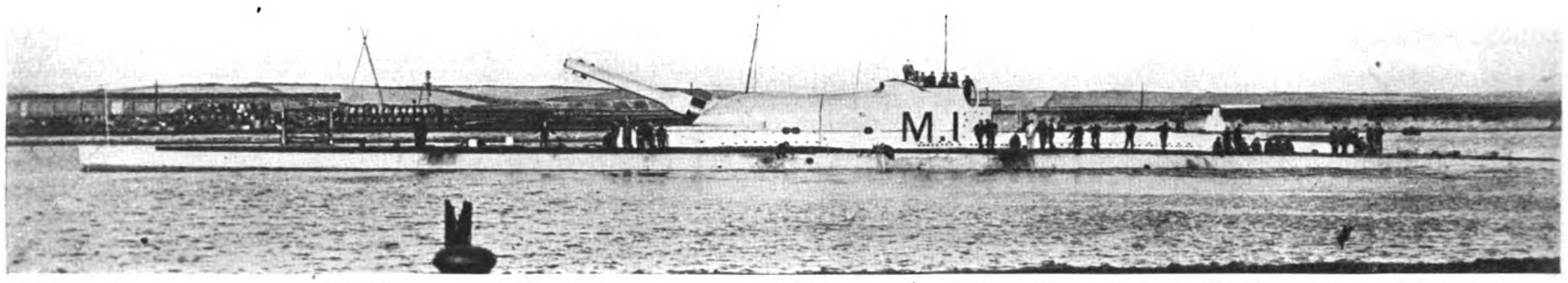


One of Gt. Britain's remarkable war-time naval developments—the submarine-monitor M. 1, equipped with a 12 in. gun

3 a m.—Starboard engine started up on five cylinders.

1.30 p. m.—Temporary joint that was made to blank off clearing valve on No. 5 engine began to leak, and continued to get worse until it was so bad as to make it impossible to stay in engine room owing to fumes.

4 p. m.—On consulting the captain he decided to shut down on starboard engine.

Nos. 1 and 3 valves (clearing) were also leaking a little. Each one was taken out and made a good job of. This work occupied the greater part of remainder of trip. Port engine continued to run satisfactorily throughout.

Thursday, 2.15 and 11.45 p. m.—Arrival at Nore (awaiting opening of boom).

Friday, 2.30 p. m.—Port engine under way to get into harbor.

Immediately on arrival the dockyard mechanics came aboard to assist, and proceeded to work on starboard engine. No. 5 cylinder head was lifted and taken ashore that evening. Clearing valve body seat cleaned up in the dockyard workships, and the head returned aboard same night.

Fitted lock nuts on starting relay valves of both main engines.

Renewed two injection air pipes and joints on starboard engines.

Crank and plunger of auxiliary compressor (received from Cowes) were fitted.

Fitted new bracket to turning gear (made by dockyard).

TRIALS AFTER ARRIVAL AT SHEERNESS

Sunday, September 5, 12.30 p. m.—Both engines were started away O. K., and after an hour's run without incident we anchored for a gun trial, which took up the greater part of afternoon.

5.30 p. m.—Returned to Sheerness.

Monday September 6.—Both engines ran at moorings under Mr. Sillinco's supervision.

Tuesday, September 7.—Proceeded to run trials outside, both engines underway, and running very nicely the whole of the trip. Main engines were reversed very frequently during the whole time vessel was underway, and not the least difficulty arose. Also auxiliary air compressor was running for the greater part of the time. This was the final test for the main and auxiliary engines. The steering engine and gear were also put through a severe test.

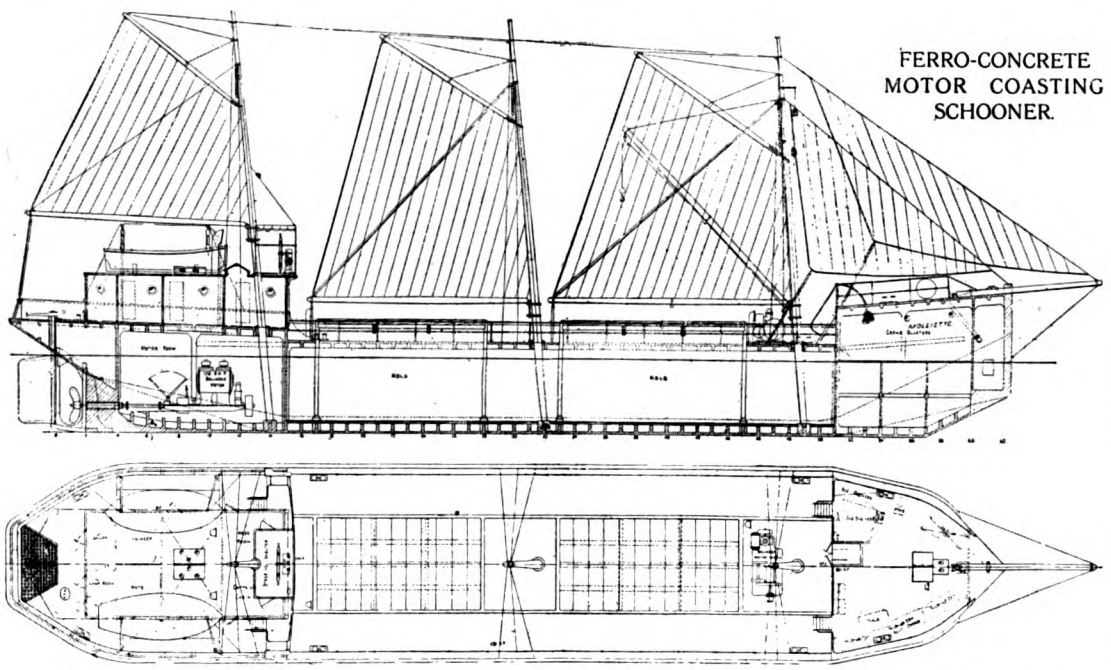
N. B.—On Tuesday's run we were without a tug both on going and coming to moorings.

GENERAL CONDITIONS WHEN STARTING UP AND LEAVING TYNEMOUTH, AND THESE WERE GENERALLY MAINTAINED THROUGH THE TRIP

Pressures at Start

Port Engine		Starboard Engine	
Blast	1,000 lbs.	Blast	1,000 lbs.
Lubricating oil	15 "	Lubricating oil	15 "
Water	24 "	Water	24 "
(one system)		Scavenge	9 "
Scavenge	6 "	**Compressor**	
Compressor		I.P. No. 7	150 lbs.
I.P. No. 7	100 lbs.	L.P. No. 7	40 "
L.P. No. 7	20 "	I.P. No. 8	110 "
I.P. No. 8	150 "	L.P. No. 8	30 "
L.P. No. 8	40 "		

Average temperature of piston cooling gear throughout the trip was 135° F.



"Moliette," a new British straight-lined concrete motor vessel, equipped with auxiliary motor power. She was described in the Dec., 1918, issue of "Motorship"

NEW MOTORSHIP "BONHEUR" SUNK BY MINE

On Christmas day the new Danish-built motorship "Bonheur," 9,700 tons d.w.c., struck a mine and sank. She was a vessel of 3,100 I.H.P., and was owned in Norway. Her engines were installed aft.

CORRECTIONS

In our last issue we referred to a motorship purchased by Mr. Francis Bustillo, of the Compania Transmediterranea. However, negotiations for the ship have not been carried on for the company in question, but for Mr. Bustillo and an associate. We are glad to make this correction.

THE RAYLTON-DIXON MOTOR MONITORS

In our last issue we gave an illustration of the British monitor "Abercrombie," which was reported to be propelled by Diesel oil-engines. This particular vessel is steam-driven. However, the twin-screw monitors M19, M20, M23, M25 and M28 are fitted with heavy-oil engines of the surface-ignition type of 640 total b.h.p. These vessels are of 600-700 tons gross. All the engines were built by the Bolinders Company of Stockholm, Sweden. The hulls were built by Sir Raylton Dixon & Co. Ltd. We referred to these vessels in our columns early last year.

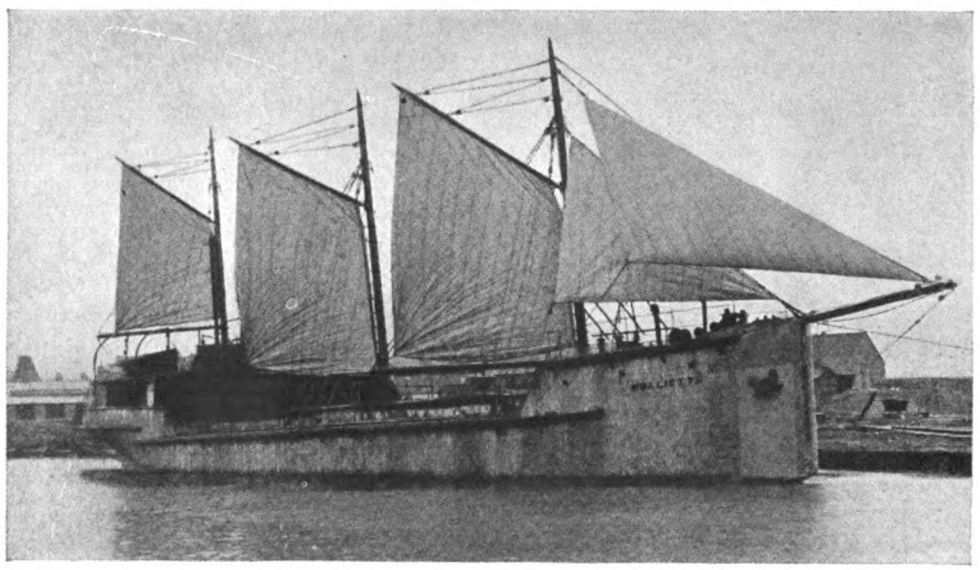
FRENCH CONCRETE MOTORSHIP WITH REDUCTION-GEARS

The first of a number of concrete motorships has just been launched on the River Seine for the purpose of coal-carrying between ports in South Wales and Rouen and Paris. This vessel has been constructed from the designs of Mr. Chas. A. Roux, and is of 500 tons d.w.c. She has the following dimensions:

Length	149 ft. 6 in.
Breadth	24 ft. 9 in.
Depth	12 ft. 3 in.
Loaded Draught	10 ft. 5 in.
Loaded Displacement	964 tons
Deadweight Capacity	500 tons

Her installation is of considerable interest, being two 4-cylinder Panhard gasoline engines of 120 B.H.P. each. These engines are arranged to run at 600 to 1200 revolutions per minute, and at the latter speed the full power of 120 B.H.P. is developed on a gasoline consumption of 22 gallons per hour for the two motors. Aft of each engine is a change-speed transmission, which provides for three movements, namely ahead, stop, and reverse, while immediately aft of this a gear of herring-bone type having a reduction of 1 to 6. Aft of the reduction gear is a hand operated brake for locking the propeller into position. The whole of the transmission-gear is mounted on Skefko Ball Bearings.

This vessel has been named "Comafram," and is said to have cost $150,000. Her loaded speed is 8 knots. In addition to the main engines there is an auxiliary gasoline motor of 10 H.P. which drives a dynamo for the electrical auxiliaries, including two electrical winches, each of 2 tons capacity.



The concrete auxiliary motorship "Moliette"

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Our Readers' Opinions

(The publication of letters does not necessarily imply Editorial endorsement of opinions expressed.)

OPERATION OF THE M.S. "SELANDIA"

To the Editor of "Motorship."
Sir:

Regarding my recent voyage aboard the Danish motor-vessel "Selandia" from Manila via the Panama Canal to New York, I have nothing but the highest praise for the vessel and for its management. I was told by the captain that the "Selandia" took on fuel in San Francisco and had enough for the voyage from there to Australia, Manila, Panama and New York; he also told me that crude-oil takes up about one-fourth the space of coal when the fuel is taken on.

From the point of view of passengers, the absence of smoke and vibration is a decided advantage in favor of a motor-vessel. While the speed of the "Selandia" did not exceed ten knots, I am informed that newer ships of this same line equipped also with Diesel engines attain a much higher speed.

From the point of view of economy in the transportation of freight and comfort for passengers, I expect to see this type of ship very widely adopted in the future.

Yours very truly,
FRANCIS BURTON HARRISON,
Governor-General of Manila,
War Department,
Bureau of Insular Affairs,
Washington, D. C.,
February 9, 1919.

[The "Selandia" is essentially a slow cargo ship and her passenger accommodation originally was installed for the convenience of the company's officials.—*Editor.*]

THEY BELIEVE IN MOTORSHIPS AT WASHINGTON, D. C.

To the Editor of "Motorship."
Sir:

I am strong for the Diesel system of propulsion for merchant ships.

Yours very truly,
J. H. ROSSETER,
Director of Operations, U. S. Shipping Board.
Washington, D. C., Jan. 29th, 1919.

PROMINENT SHIPOWNER'S OPINION

To the Editor of "Motorship."
Sir:

Motorships will undoubtedly be the most successful vessel in the future, in so far as economy is concerned. The performance of the "Bullaren," description of which was in the January issue of "Motorship," is most remarkable.

Yours very truly,
H. H. RAYMOND,
President, Mallory Steamship Co.
Pier 36, North River, New York.

PERFORMANCE OF THE M.S. "LIBBY MAINE"

To the Editor of "Motorship."
Sir:—

I was very much surprised to read the item about the "Libby Maine" in the December issue. To say the least it sounds somewhat "fishy" to anyone who is familiar with the operating of ships and distances between ports. I wish to state for your information that this vessel sails on strictly steamship course. The distance covered between Seattle and Honolulu was 2440 miles, that is from the full-speed, all-clear, bell off Colman Dock to the first slow bell off the entrance to Honolulu harbor. The total running time was 14 days, 18 hours, 15 mins., giving the vessel an average speed of 6.88 knots. The fuel consumption for the voyage was 259.5 barrels or 17.58 barrels for 24 hours or 4.46 gallons per mile.

These figures are taken from my log-book. If in the future you care to have any data in regards to the performance of this vessel or her Dow-Diesel engines I am only too glad to give you all information desired. As I write, the engines are working perfectly and the next twelve hours will see us in Honolulu after a non-stop trip of about the same running time as last trip. We will take on additional fuel and water and then proceed to Manila. After discharging our cargo we shall proceed to Hong Kong to load a return cargo for the Pacific coast. I expect to make the return voyage direct without calling at ports en route for fuel. Inclosed find money-order to cover cost of one years subscription to "Motorship."

Yours very truly,
ALBERT T. A. FABEL.
Chief-Engineer, M.S. "Libby Maine."

[This means over 3,000 tons of cargo carried with a fuel cost of about $0.35 per mile.—Editor]

THE BRITISH MOTORSHIP "GLENAPP"

To the Editor of "Motorship":
Sir:

In the February issue of "Motorship," under heading "World's Highest Power Merchant Motorship," a description of the twin screw Motorship "Glenapp" is given and also in detail some of the auxiliaries.

I wish to call your attention to discrepancies in the voltage mentioned, as by perusing the article, three different voltages are quoted; also the auxiliary oil-engines are described in two places with different horsepower.

The article also mentions the cylinder compression as 600 lbs. Is that possible?

You have no doubt seen the article or report gotten out by some of the U. S. S. B. E. F. C. officials in New Orleans, the Indicator Diagram (and details pertaining to same given on the back of the Indicator Card) are used as part of the article. This card gives the cylinder diameters as 850 M.M. as compared with yours of 760 M.M.

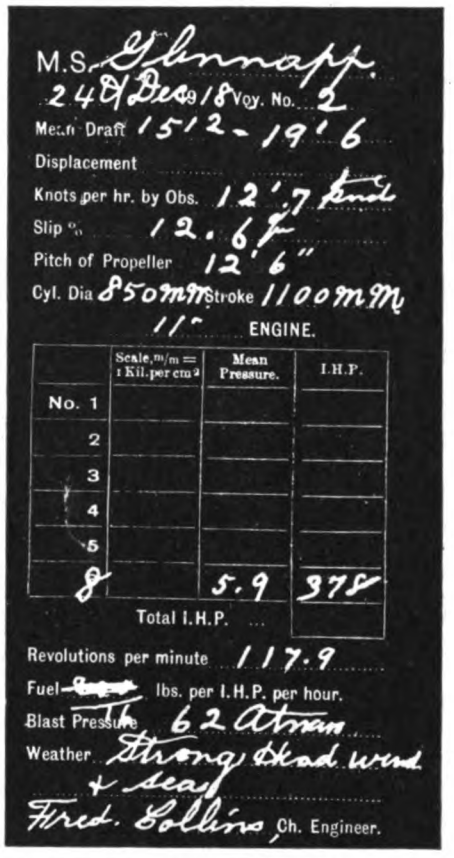
For the sake of right impressions to ship owners and builders, as well as engineers connected with this special branch of work, I hope that in the future "Motorship" will give more reliable information. Others besides myself agree with me in this writing.

Very truly yours,
JOHN W. MORTON.

Philadelphia, Pa.

[We always make every effort to ensure that what we publish is correct, but such is not always possible, as in the present case, where the owner gave instructions to the officers that no information was to be divulged. We have before us a copy of Mr. Haley's report to the U. S. Emergency Fleet Corp. We have also seen a report on this vessel made by the engineers of the U. S. Shipping Board.

Regarding the diameter of cylinders of the engines of the "Glenapp," the figure 760 M.M. given



Indicator reading from one of the engines of the m.s. "Glenapp." The cylinder diameter given is incorrect.

by "Motorship" not only is approximately correct, but probably exactly correct. Also that the diameter given in Mr. Haley's report and also given on the indicator card obtained by the Emergency Fleet Corp. is incorrect, so that "Motorship" is not giving such unreliable information as stated by you.

Everything published in our issue regarding the "Glenapp" was checked with the information contained in the Shipping Board Engineers' report, and in practically all instances was found to be the same. We have before us Lloyd's Register of Shipping which gives the diameter of the "Glenapp's" engines as 29½ by 43 5/16 stroke, and that the engines each have 8 cylinders.

If you will refer to the indicator-card attached to the Emergency Fleet Corp.'s report, it must be obvious to you that a cylinder 850 M.M. diameter by 1100 M.M. stroke would develop more than 378 I.H.P. at 117.9 R.P.M. with a mean-pressure of 5.9 atmosphere

Let us make a simple calculation, as follows:

Ind. H.P. cyl. as shown in card = ...387 H.P.
Corresp. R.P.M.....118. —
Mean Ind. Press.....5.9 atm.

With these figures there results a cylinder area giving the piston speed of:

$$1 \text{ Med. Pist. speed } C = \frac{S \times N}{30} \quad \frac{1{,}100 \times 118}{30} = 4{,}325 \text{ metre/sec.}$$

$$F = \frac{300 \times N:}{p: \times C} = \frac{300 \times 378}{5.9 \times 4.325} == 4470 \text{ c/2} == \text{m}$$

Result. Diam. = Approx. 755 m/m

Several other dimensions do not tally. For instance, one report gives the propellers as being 12 ft. 6 in. diameter by 12 ft. 6 in. pitch. The other report gives the dimensions as 14 ft. 6 in. diameter by 12 ft. 6 in. pitch. Also, one report gives the propeller shaft as being 15 ins. diameter and the other report says 16.14 ins.

Our own representatives, and the Shipping Board's representatives were told that the crank-pins of the main engines were of 14 in. diameter. Obviously they must have been about 18 in. Unfortunately we were unable to make a personal visit, but seeing that none of the British journals have published descriptions, we think that under the circumstances we gave a very useful article.—Editor.]

CAN AMERICANS BUILD RELIABLE DIESEL ENGINES?

To the Editor of "Motorship."
Sir:

You have requested comments on the propelling installation of the M.S. "Bullaren," after my visit arranged for by "Motorship."

It has been clearly illustrated that successful marine Diesel engines can be manufactured from the start by well-equipped engineering concerns that have specialized in other lines, as information furnished to licensees by established manufacturers bears signs of confidence in adopted constructions.

To those who have followed the development and progress of this highly economic type of engine, it is no secret that only slight modifications have been made in the last couple of years, which speaks for the reliability of the engines in general, as the numerous long voyages made by various vessels equipped with Diesel engines of different designs have not escaped attention. The installation of the M.S. "Bullaren" is a duplicate in general of those that have crossed the ocean for the last two or three years and shows no difference in detail.

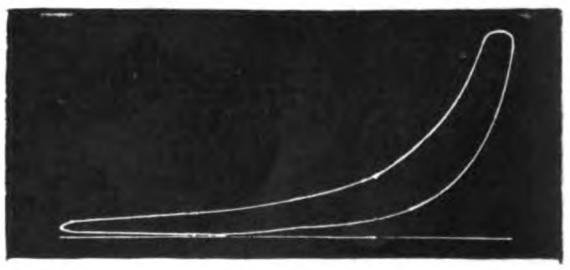
The gratifying tendency today to watch performances while we are on the verge of entering the competitive field in ocean trade and particularly the fact that many prominent Americans in business, shipping and engineering circles are showing intense interest, is the forerunner of a period in which Uncle Sam is to take a leading part in the manufacturing of Diesel engines.

Once interested, success will be ours without doubt, and, furthermore, the last word is not yet spoken.

Let's go to it.

Very truly yours,
HUBERT C. VERHEY,
Member American Society of Mechanical Engineers; Society of Naval Architects and Marine Engineers.

Philadelphia, Pa.



Indicator card from the engine of the m.s. "Glenapp"

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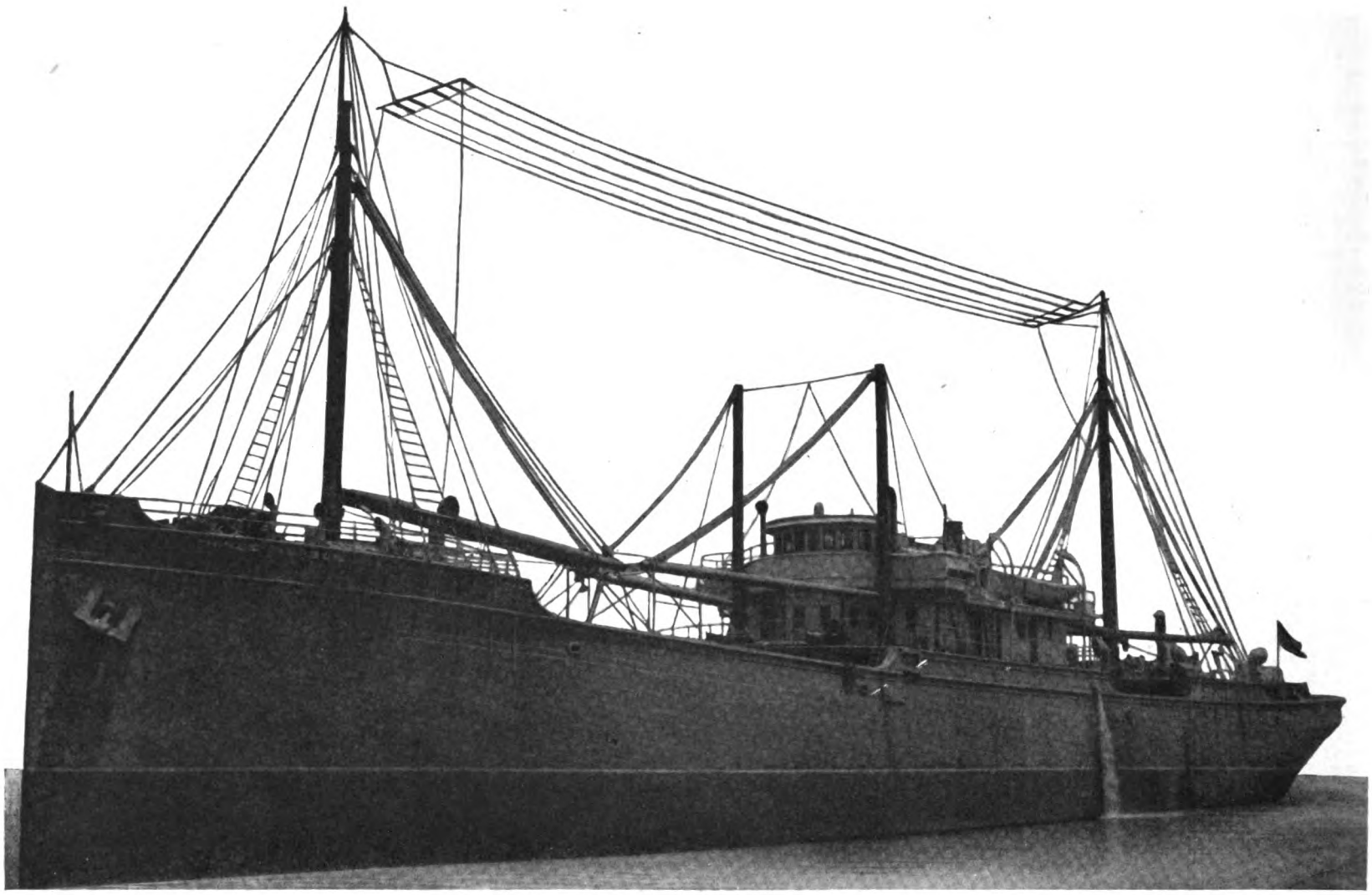

The American motorship "James Timpson"

One of America's Successful Motorships

Operation of the Winton Diesel-Engined Full-Powered Wooden Freighter "James Timpson"—Satisfactory Use of Reduction Gearing—Total Repair Costs in 1,650 Hours Running Time Less Than $300.00

FREQUENTLY,—or we should say, too frequently—we hear the plaint that "American engineers cannot build or operate marine Diesel-engines and that consequently shipowners who prefer to support domestic industries must perforce turn to steam for propelling power for their ships." One of the best-known shipowners on the Pacific coast, who recently chartered three underpowered, poorly designed and constructed wooden auxiliaries, the captains and owners of which endeavored to run them as fully-powered vessels, expressed his opinion to us that good Diesel-engines are unobtainable in the U. S. A. and so is turning to steam machinery for his next two ships. Apperently his sole reason for assuming that American-built Diesel engines are unreliable or unobtainable is his unfortunate experience with the underpowered auxiliaries referred to, entirely overlooking that in a sense his own lack of knowledge—due to not having thoroughly investigated the motorship and oil-engine subjects—was partly responsible for his unfortunate experiences with the said auxiliaries. It is up to an owner to pick-out a good engine when ordering a ship, and it is he who is responsible.

Furthermore he finishes his letter with the remark that he is getting too old to "experiment' and that he will stick to steam until his boats are driven out of business and then he will get as good a Diesel engine as the other man. It seems difficult to believe that a successful business man—for he is a millionare—could adopt such a retrogressive attitude in these enlightened days. But, we have his opinions in cold type before us as we write, so it is not merely journalistic imagination on our part.

Now, this shipowner's business was largely built-up by trans-Pacific trade with Japan, so the likelihood of his two new steamships being driven out of business may occur almost before they leave the builder's yard if he does place the proposed order, for there is every indication that under the fostering of the Japanese government a fleet of cheaply-operated Diesel-driven cargo motorships of large size and good speed soon will be in service between Japan and the United States. The Japanese government, we may add, did not pay a well-known successful European Diesel-engine builder three-quarters of a million dollars for drawings without something tangible in view. All the leading Japanese shipyards are said to be benefiting from this transaction.

The moral of all this is, of course, do not stay your hand just because you have an idea, or because someone has told you that reliable Diesel engines for large ships cannot be obtained in America. Given good designs, we have American engineering companies who could construct Diesel engines of high powers equal to the best turned-out by European builders.

This leads us to the subject of the heading of this article. In this vessel—the "James Timpson"—there are a number of factors which theoretically offered possibilities for unreliable operation, yet despite these said factors she has proven after—months' service to be both reliable and successful so far as her Diesel installation is concerned. One part of her machinery has given constant trouble, and that, curiously enough, is her **steam** donkey-boiler, which alone has held her many weeks in port for repairs and alterations. But, the Diesel engines have not given any trouble at all.

C. K. Wirosteck, Chief-Engineer of the "James Timpson"

The factors that some engineers might term theoretically detrimental, are:

(A) Her engines are of moderately high-speed type.

(B) Engine has no crosshead and guides, claimed by many engineers to be very advisable for marine work.

(C) Was equipped with reduction-gears between engine-shaft and propeller shaft, some designs of which transmission have given so much trouble where used with steam-turbine propulsion.

(D) Engines are of too low power for size of ship.

(E) Hull is a war-time production of wood, and such constructions when steam-powered have frequently proved dismal failures.

(F) Difficulty of maintenance of alignment of shafting.

Yet, despite the above the American-built Diesel engines in the "James Timpson" came-up smiling after every voyage, and their successful and reliable operation under such conditions is a credit to all concerned with her design construction and operation—both hull and machinery—with the sole exception of the troublesome donkey-boiler already referred to. At the same time we must be strictly impartial and fair and point out that the Diesel engines are moderate in power, and are of cylinder bore and stroke dimensions where heat stresses and strains do not form such a difficult problem as do engines of treble or quadruple the power, consequently, if well-built, the stresses are more easily taken care of. But the useful and valuable experiences with these engines naturally have given the designers excellent knowledge, and they are confident that the two 1250 H.P. Diesel engines now building at their works will give just as reliable results. Her reduction-gears have given

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excellent service and these we will shortly refer to.

Up to the time of writing the "James Timpson" which is considerably underpowered—has logged 14,500 miles in 1650 hours actual running time, and has had less than $300 spent in repairs to her main Diesel engines. This distance may not seem very great, but her loaded speed only averages 8.78 knots, so she takes rather a long time to cover any great distance. When it is considered that her loaded-displacement is in excess of 5,000 tons and that her propelling power is only 1,000 BHP. the results are really excellent. (Her net cargo capacity is 3,000 tons). Bronze propellers have just been fitted and her speed now is better.

Compare her performances with some of the recently built American wooden steamers which cannot carry nearly so much net-cargo as the "James Timpson," but which have 50 per cent more propulsive power. The speed of many of them have averaged a knot less, and in rough weather actually are driven backwards. In heavy seas they are like corks, and their propellers constantly race with consequent loss of speed, whereas the propellers of the "James Timpson" do not race, due to one of the peculiar fundamental features of the Diesel engine, whereby sudden relief of load automatically and instantly cuts off all power, which, by the way, has been too thoroughly discussed in our columns to need re-detailing here.

The following are the voyages of the "James Timpson":

(1)	Vancouver	Levinton, Ore.
(2)	Levinton, Ore	Marshfield, Ore.
(3)	Marshfield, Ore	San Francisco, Cal.
(4)	San Francisco, Cal	Bay Point, Cal.
(5)	Bay Point, Cal	San Francisco, Cal.
(6)	San Francisco, Cal	Eureka, Cal.
(7)	Eureka, Cal	San Francisco, Cal.
(8)	San Francisco, Cal	Panama, Canal Zone
(9)	Panama	Mejellones, Chili
(10)	Mejellones	Iquiqui, Chili
(11)	Iquiqui	Caleta Buena, Chili
(12)	Caleta Buean	Panama, Canal Zone
(13)	Panama	Colon, Canal Zone
(14)	Colon	Baltimore, Md.
(15)	Baltimore	Norfolk, Va.
(16)	Norfolk	New York

Her daily fuel-consumption is between 4 and 5 tons (28 to 35 barrels) with the engines running at continuous full load, so that it is not surprising that she only used 2,200 barrels of fuel-oil during the above voyages, including for the donkey-boiler and auxiliaries. This means 3,000 tons of cargo carried on an average of 1 1/3 barrels of oil-fuel per hour.

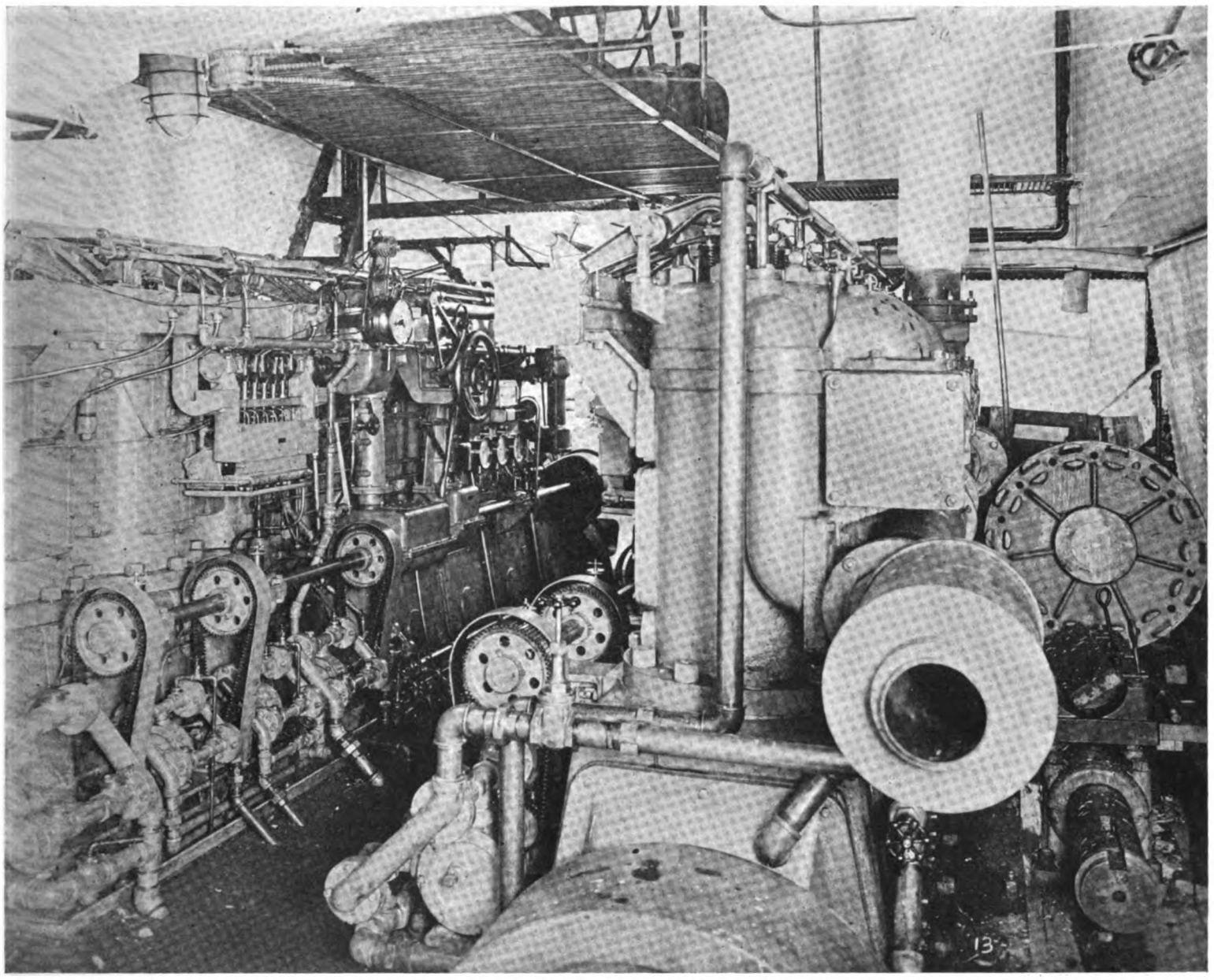
The lubricating-oil perhaps has been somewhat high, averaging 14 gallons per 24 hour-day, which is more than the quantity used by 4,000 I.H.P. engines of the 9,500 tons motorship "Bullaren." Doubtless an efficient and rapid filter system, such as the De Laval would remedy this to an appreciable extent. But, in any event the quantity is not sufficient to interfere with her economy; as, supposing it had been cut down to about 7 gallons per day, the total saving for the 14,500 nautical miles covered would have approximated but $350.00, or comparatively a small amount compared with her other economies.

The hull was built of wood by the Standifer Construction Corpn., of Vancouver, Wash., U. S. A., who have made an excellent job, showing that a well-designed and well-constructed wooden hull makes a reliable ship that should not be compared with wooden vessels built in yards without proper experience. The owner recently told Cox & Stevens that she is the best wooden ship built.

We now will quote the general dimensions of the m.s. "James Timpson."

Length O.A.	280 ft.
Length B.P.	268 ft.
Breadth	46 ft.
Depth	24 ft.
Average Cargo-Capacity	3,000 tons
Loaded-Displacement	5,300 tons
Loaded-draught	23 ft.
Maximum Power	1,000 b.h.p.
Approximate indicated-horse-power	1,300 I.H.P.
No. of Propellers	Two
Maximum Engine-Speed	300 r.p.m.
Average Engine-Speed	265-275 r.p.m.
Propeller Speed	85-90 r.p.m.
Propeller Dia. and Pitch (4 blades)	9 ft. 8 in. x 11 ft.
Type of Diesel Engines	Six-cylinder, single-acting, direct-reversible, four-cycle, trunk-piston
Bore and Stroke	12 5/16 in. x 18 in.
Average Fully Loaded Speed	6.38 knots
Daily Fuel-Consumption	4 to 5 tons
Daily Oil-Consumption	14 gallons
Cruising Radius	15,000 nautical miles
Auxiliary Machinery	Steam-driven
Owners	I. T. Williams & Sons, New York
Designers	Cox & Stevens, New York
Builders of Vessel,	Standifer Constr. Corpn., Vancouver, Wash.
Builders of Main Engines,	Winton Engine Works, Cleveland, Ohio
Builders of Reduction Gear,	The Falk Co., Milwaukee, Wisc.
Electrical Steering-Gear,	Herzog Electrical Engineering Co.
Refrigerating Machinery	Clothel type
Chief-Engineer	Chas. K. Wirosteck

It will be noted that the Herzog electrical steering gear has been installed, and this is operated by a 1½ B.H.P. electric motor connected to a reduction-gear attached to the rudder stock. This steering-gear is handled by a little lever on the bridge-deck and it is possible to move from hard-a-port to hard-a-starboard in 20 seconds. The principle is one of magnets, and the "James Timpson" has been thus steered since her trial trip without any trouble.



The engine-room of the m.s. "James Timpson," looking from the forward end. Note the chain-driven Viking water and lubricating-oil pumps on one of the two Winton Diesel engines

One of the most interesting features of the machinery installation is to be found in the transmission of power from the main Diesel engines to the propellers, which in this ship we understand has proven entirely satisfactory. If adopted with vessels of larger size and higher power, and if it proves successful in such cases, gear-reduction transmission will prove a strong competitor to electrical transmission where Diesel power is concerned. It remains to be seen, of course, if reduction-gears will prove reliable with higher powers, but there seems to be no substantial reason why the system should not receive a thorough trial. If good results are obtained, and if the League of Nations decides that there shall be no submarines, an excellent use can be made of the 1000 bhp. 1500 bhp. 1600 bhp. 2000 bhp. and 2400 bhp. Diesel engines in the British, French, Italian and American submarines by using gear-reduction. Thus many existing steamships could be converted to motor power at low cost. In Russia there still are dozens of old Diesel motorships using transmission gears in conjunction with pneumatic slipping

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clutches. In fact electrical transmission, then in its early stages, was abandoned in favor of the gear transmission for the astern running. Also many of the high-powered Russian paddle-tugs use reduction-gears and Diesel engines with remarkable success.

The reduction-gears of the "James Timpson" are of the Falk double-helical type with both gears floating and built with a ratio of 3 to 1. Flexible couplings connect reduction-gears to the main engines, and while the gears have given no trouble we believe that once or twice the flexible coupling has caused a little bother. The flexible coupling was not of Falk design. The thrust-bearings are of the same type as are being fitted to the Diesel engines of the motorships now building for the U. S. Emergency Fleet Corporation, and judging by the anticipated results it looks as if this design of thrust-bearing will be extensively adopted in the future.

As we previously have mentioned the auxiliaries are steam driven, and the only troubles and delays met with have been due solely to the donkey-boiler which has leaked, and the oil-firing system of which has not been efficient as it might have been. After about six weeks in port while repairs were being carried out the ship was loaded ready to sail, but more boiler troubles developed and the chief-engineer refused to proceed to sea until further alterations were carried out.

Steam is furnished by this boiler for the bilge-pumps, auxiliary air-compressor, auxiliary 12 K.W. electric-generator, deck winches, and the heating system of the ship. The main electric-generator is driven by a 15 B.H.P. Fairbanks-Morse surface-ignition oil-engine using the same fuel as the main engines and donkey-boiler.

Finally, let us suggest to shipowners that if they are not getting the same excellent results from their own American-built motorships, just probe a little and ascertain the real cause, instead of condemning their oil engines.

Performance of The Canadian Auxiliary "Margaret Haney"

Running on Persian Crude-Oil Taken Direct from Wells Without Semi-Refining

FOR nearly two years the 2500-tons d.w.c. motor-auxiliary wooden schooner "Margaret Haney" has been operating regularly between Bombay and Basrah, a voyage that she averages twelve days each way on a total of 12 tons of oil-fuel. This fuel, by the way, is picked-up at Abadan on the Tigris, near Basrah, at the storage tanks near the refineries of the Anglo-Persian Oil Co., which is a subsidiary of the Royal Dutch Petroleum Co., and of which the British Admiralty owns ten million dollars worth of stock, or a little over 50% of the total shares.

This is a crude-oil from the new Persian oil fields that promise to give the largest oil production in the world. Curiously enough it has proved to be even more satisfactory than kerosene obtained from the same source, since, although it is, of course, slightly dirtier, it has lubricating qualities which are very favorable to the satisfactory working of the fuel-pumps of the engine. With the kerosene, which has no such properties of lubrication, the pumps are apt to stick after prolonged running, say, after 10 days continuous operation. As a proof of the good combustion, it may be mentioned that, each time the exhaust-box has been opened up for cleaning after six months' service, there has been scarcely any deposit of carbon inside.

This fact is both interesting and important as it opens up remarkable possibilities for the use of this oil with large Diesel-driven ships, which can fuel at any convenient fuel-storage depot and cruise from port to port around the world without re-bunkering.

As far at its successful use with the surface-ignition type of low-combustion oil-engines of the "Margaret Haney" is concerned, this result is undoubtedly partly due to this special system employed with the Bolinders engines, in which the nozzle-valve is so arranged that compressed-air at a pressure of 30 atmospheres enters the cylinder through a small centrally-placed hole in the nozzle-valve, whilst the fuel is admitted through the same valve but through an annular space around the spindle on which the air hole is pierced. The fuel, moreover, is caused to take a spiral path, so that it enters the cylinder with a whirling motion and is thus readily atomized, which ensures good combustion.

Another reason is that the engineers of this ship take proper interest in their engines, and have "stayed on the job" for 20 months, despite the hot climate.

During the whole time she has been on the Bombay-Basrah run virtually no trouble has been experienced with the engines, except that on one occasion one of the crossheads gave out due to the sight-feed lubricator breaking, and the oil escaping so that the crosshead remained unlubricated. On this occasion, as it was found to be impossible to do the repair at sea, one engine was run on one cylinder until the ship reached port.

For lubrication Vacuum oil is used, the quantity being about nine gallons per day of 24 hours, and in order to economize in this direction the used oil, after it drops down into the crank chamber, is filtered and employed over again for the main bearings, although it is found necessary to use fresh oil for cylinder lubrication.

The "Margaret Haney" is one of six similar vessels built in 1916 at the yard of the Cameron-Genoa Mills Shipbuilding Co., and is propelled by two 160 B.H.P. Bolinders oil-engines. She was illustrated in "Motorship" some time ago. After her trial trip she left Vancouver for Bombay and the three engineers in the ship were absolutely new to this type of engine, and the only help they had was from one donkeyman who took the chief engineer's watch. Yet the two engines were running day and night during practically the whole voyage, which lasted 85 days, without any trouble at all except that one big-end bearing had to be renewed at the end of the voyage.

This clearly shows that this type of engine, when well-designed, well-constructed, well-installed, and properly looked-after is reliable in every sense of the word and those of our shipowners who have experienced trouble with this class of vessel and motive power will do well to bear this in mind. If they will carefully analyze their own particular cases they will find that the trouble was not the fault of the oil-engines, but partly their own fault and partly the fault of its operators, or the shipbuilders who carried out the installation work.

GOVERNOR-GENERAL F. B. HARRISON TRAVELS FROM THE PHILIPPINE ISLANDS TO NEW YORK ABOARD VETERAN MOTORSHIP "SELANDIA"

On Sunday, Feb. 2, 1919, the veteran Danish Diesel-driven motorship "Selandia" arrived in New York harbor having aboard as a distinguished passenger the Hon. Francis Burton Harrison, Governor-General of the Philippine Islands. Although the "Selandia" is the second ocean-going full powered motorship built, having been constructed in 1912, she made a splendind passage via the Panama Canal, covering the 9,500 nautical miles (approximately) in 55 days, including calls at Iloilo, Colon, and Kingston, Jamaica, and the passage through the Canal. From Manilia to Colon she averaged 221 knots per day, which is pretty good for a seven year old "tramp" motorship designed for a speed of 10½ knots. Yet we are told by some people that Diesel engines are unreliable! The run from Kingston also was made in good time the "Selandia" having left there on January 26th.

The motorship "Selandia" is a full-powered twin-screw steel ship, with excellent state-room accommodation for about 12 passengers, dining saloon, music saloon and smoking room, and we had the pleasure of visiting her in 1912 in London when she was on her maiden voyage. Her dead-weight capacity is 7400 tons. Her two Diesel-engines are of the four-cycle type and together develop 2240 I. H. P. at 125 R. P. M. In the April issue of "Motorship" we expect to publish a complete story on her seven years' operation.

WHERE BUNKER-OIL FOR MOTORSHIPS CAN BE OBTAINED

Fuel-oil Carried in Nearly Sixty Ports

A few of the ports at which stocks of fuel-oil are kept may be mentioned as an indication of the readiness with which oil can be obtained on almost any run, especially when it is considered that the average motorship has bunker capacity for at least 20,000 nautical miles. Going east for instance, motorships may bunker at Alexandria, Port Said, Suez, Bombay, Abadan (Mesopotamia), Karachi, Colombo, Madras, Calcutta, Singapore, Bankok, Batavia, Palembang, Sabang, Puloc Samboe, Soerabaya, Shanghai, Hong Kong, Nagasaki, Tarakan, many of these ports being practically adjacent to the oilfields, such as Abadan, Palembang, Singapore, and Tarakan.

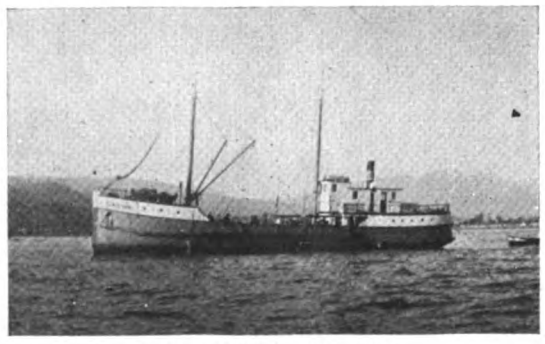
If a ship continues its voyage from the Far East to Western America, thence through the Panama Canal (stations at both ends) to Europe, we find more "oiling ports" on the run, including Honolulu, San Francisco, Seattle, Portland, Richmond, San Pedro, Panama, Colon, then Lisbon, and Thameshaven. For the South African run oil is bunkered at Capetown, whilst for the motorships trading on the Australian route there are stocks at Sydney and Melbourne and South America is covered by Buenos Aires.

Among other ports where good fuel-oil can be obtained are London, Liverpool, New York, Philadelphia, Boston, Norfolk, Adelaide, Balik Bappan, Bombay, Curacao, La Guayra, Madras, Maracaibo, Montreal, Panakalor (Berandan), Penang, Port Said, Puerto-Cabello, Rotterdam, Saitozaki, Tampico, Trinidad, and Vancouver.

Thus there are at least 57 ports in various parts of the world where storage-tanks have been installed for the purpose of supplying fuel-oil to motorships.

MOTORSHIP CARRIES SEVEN THOUSAND SHARKS

When the motorship "Gryme" arrived at San Diego on Jan. 4th, she had in her cargo holds



The motorship "Gryme"

the dried carcasses of 7,000 sharks cut in half, which she brought from Guadaloupe Island and Ensenada, Lower California, for fertilizer purposes.

The motorship "Gryme" is owned by the Vancouver & San Diego Navigation Co., Ltd. (Mr. Geo. W. Beermaker, President), and is 115 ft. long. Her gross-tonnage is 110 tons. She has a crew of nine men. Her power unit is a four-cylinder Union distillate-motor of 150 b.h.p. She is engaged in weekly runs between San Diego and Ensenada.

THE OCEAN FREIGHT-RATE REDUCTIONS

U. S. Shipping Board Officials Differ in Opinions

Apropos our editorial leader headed "The Falling of the Barometer" in this issue, which discusses the recent drastic cut in freight rates, an interesting situation of affairs was indicated in the New York "Herald" of February 4th, the opinions of two prominent Shipping Board officials being given, as follows, Mr. Rossetter's statement was made after being shown Mr. Clegg's remarks:

MR. A. E. CLEGG

"Several weeks ago discussions began between the Shipping Board, the British Ministry of Shipping and individual lines on the subject of freight rates. As a result we arrived at reductions to the United Kingdom, and we then took up rates to other countries as we had the opportunity. We have established a basis of rates satisfactory to all and which fit the situation at present. Several additional trade routes are to receive attention soon."

MR. J. E. ROSSETTER

"Reductions in ocean freight rates made during the last ten days on cargoes carried in American bottoms have been forced by British shipping interests. Further reductions on the part of British shipowners are likely and they will be met 'step by step.'"

Mr. Rossetter is the Director of Operations of the U. S. Shipping Board, Washington, D. C., and Mr. Clegg is the Assistant-Director of Operations, and is in charge of the New York Office of the Shipping Control Committee.

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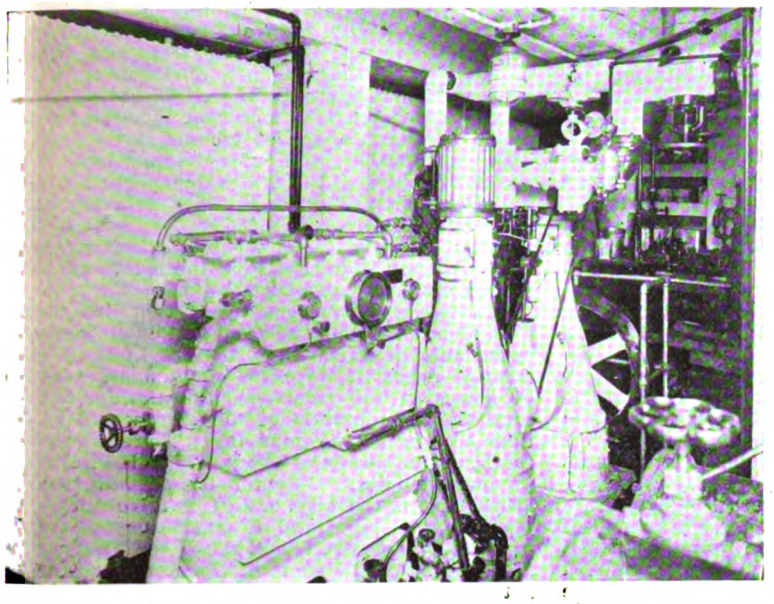
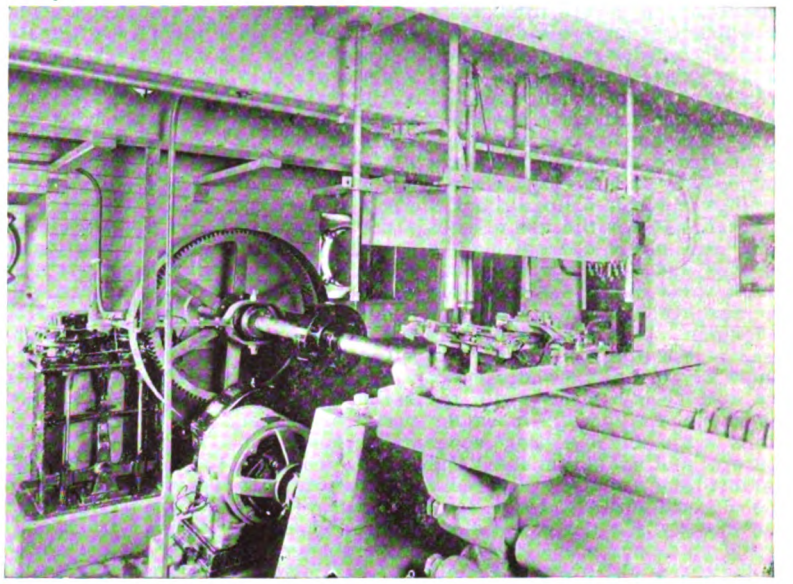
Interior Views of the American Motorship "James Timpson"

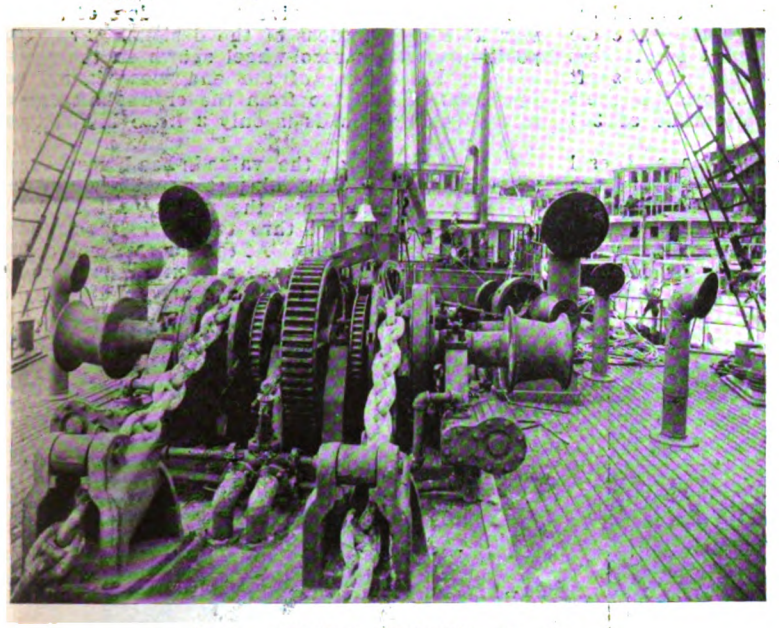
THE wooden motorship "James Timpson" was built at Portland, Oregon, early this year, and is propelled by two 500 b.h.p. Winton Diesel oil-engines, each having eight cylinders, 12 15/16" bore by 18" stroke, and develop their rated power at 250 R.P.M. They are of the four-cycle trunk-piston, direct-reversible type. The vessel is of 3,500 tons d.w.c. and was designed by Cox & Stevens for the Ichabod T. Williams Company of New York, N. Y. The first illustration of the vessel was published on page 9 of our May, 1918, issue. We understand that her Diesel engines are running excellently, but that considerable trouble is being experienced with the steam donkey boiler.



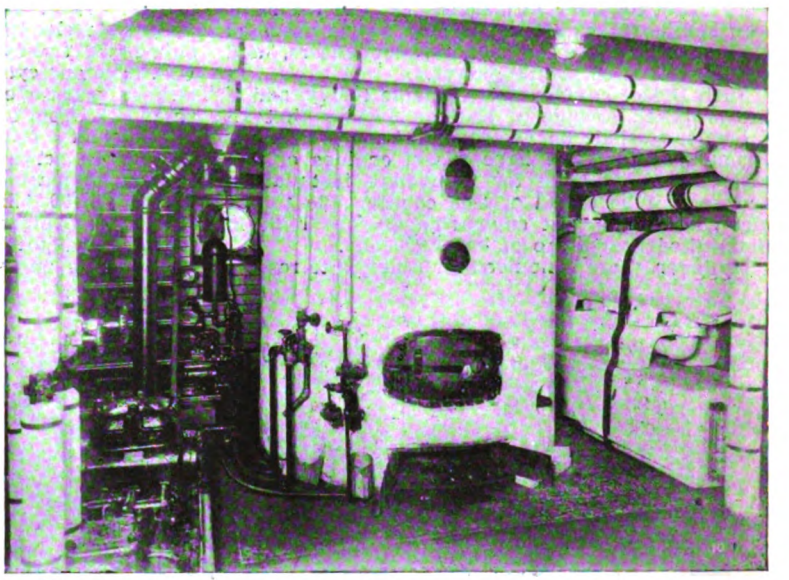
Steam-driven Auxiliary Air-Compressor Set. The air-compressor is a Winton production



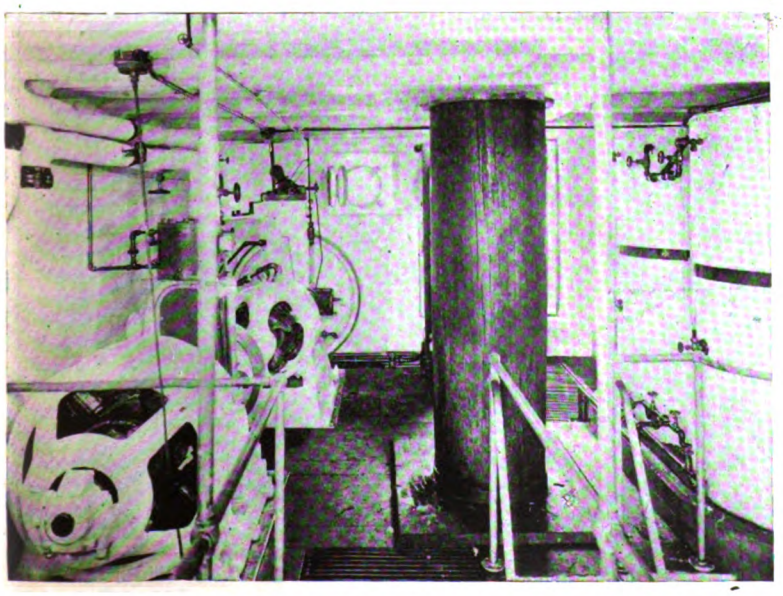
View of Herzog electric steering gear, the motor and gear for actuating screw gear shown at the right-hand, attached direct to the rudder head



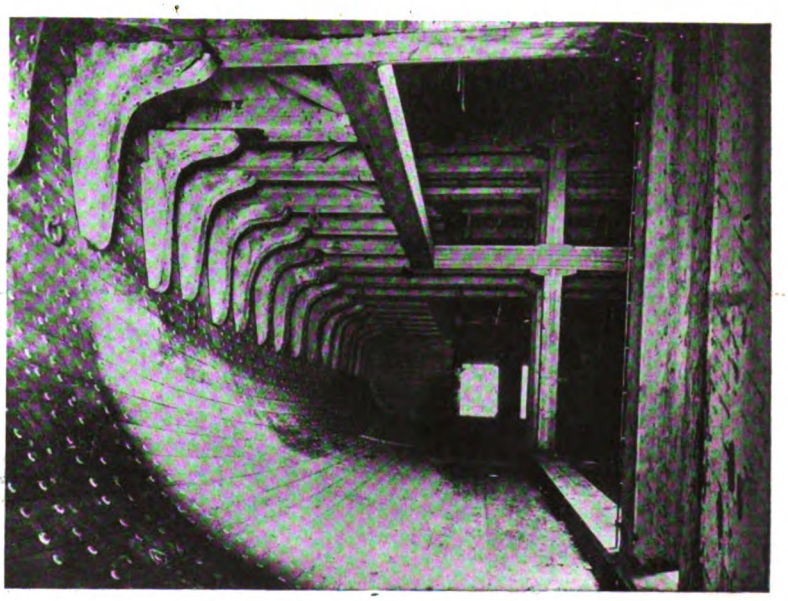
Anchor, Windlass, Chain Stoppers, etc.



Donkey-boiler supplying steam for heating, lighting and operating deck power. This is the only part of the machinery that has given trouble



Entrance to engine-room, showing Fairbanks-Morse electric generator set



General view of the wooden construction of the hull

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Schneider 2150 I.H.P. Naval-Type Diesel Engine

Electric-Drive and Reduction-Gears Offer Possibilities of Extensive Use of this Type of Engine for Converting Existing Merchant Steamships, Especially if League of Nations Bars Submarines

IN one part of this issue of "Motorship" is given a proposal by a well-known American engineer for the use of moderately high-speed Diesel engines, such as are used in submarines, for the propulsion of large merchant ships in conjunction with electric-drive, and on the other pages is given an account of the operation of an American motor-freighter driven by somewhat similar type of Diesel engines through reduction gears. Obviously if both systems of transmission are developed to a point where they can be regarded as strictly reliable and satisfactory when used with Diesel engines of treble or four times the power, there is a great field for the use of submarine engines to take the place of coal and oil-burning steam-engines and boilers in hundreds of existing merchant ships of the largest size, and thus greatly increase their economy, capacity, and all-round efficiency. Also, to enable the Diesel engine to be used at the present time for propelling big ocean liners of up to 20,000 horse-power. And, if America can to-day place swift transatlantic motor-liners on the ocean, it would mean passenger ships with an operating economy hitherto unknown, and would enable America to compete against any country who remained steadfast to the old coal-burning system for passenger vessels. Incidentally, the absence of cinders, dirt and smoke would be a source of delight to the passengers as is indicated by Governor-General F. B. Harrison elsewhere in this issue.

The advantage, of course, of the high-powered naval Diesel engine for merchant ship propulsion. would be the small space occupied, and the better manufacturing facilities now available, and ten Diesel engines of say 1,000 I.H.P. or six sets of 2,000 I.H.P. together with their electrical transmission equipment would not occupy nearly as much engine-room space as boilers, condensers, and steam-engines of similar power.

Such Diesel engines are available to-day, and if the proposed League of Nations decides that all submarines shall be destroyed, France, England, Japan and Italy will have Diesel engines of this high power available for immediate installation, and so will be ahead of this country due to the fact that the largest submarine engines built in the United States are of but 1,000 bhp.

However, there is no need for America to remain behind very long, because there are in this country at the present time complete detailed constructional drawings of a naval-type Diesel engine, having an output of over 2,000 I.H.P. from eight cylinders, the originals of which are giving good service in the French navy. These drawings are available to the U. S. Government or to any responsible and enterprising American shipbuilding or engineering concern who will make the necessary investment.

"Motorship" is privileged to publish the first illustrated description of this remarkable marine oil engine, thus once again giving our readers a service unobtainable elsewhere in the publication of the latest marine oil engineering developments of Europe and America.

We refer to the most recent design of naval Diesel engine produced by Schneider et Cie, the largest engineering and shipbuilding company in France, whose experience with high-powered submarine engines probably is unequalled, except perhaps by Vickers of England. At one period of the war Schneiders employed over 150,000 men and women. In dealing with the Schneider engine a certain amount of sentiment exists, as it was this company who supplied practically every large gun to American "doughboys" in France, including the famous "75 mm.," and who furnished drawings of their latest and most effective guns to Italy, America and allies. So, what Schneiders did for the U. S. A. during the war they appear to be willing to repeat in our peaceable merchant ship programme. They have, of course, the slow-speed, crosshead-type merchant-ship Diesel engines of high-power, such as are generally adopted for cargo ships, but these will be the subject of a later article. Their experiences cover both four-cycle and two-cycle Diesel engines, and their largest slow-speed two-cycle engine developed 1200 shaft H.P. from one cylinder 3 ft. 3⅝ ins. bore, and their largest four-cycle engine had an output of 300 shaft H.P. from one cylinder.

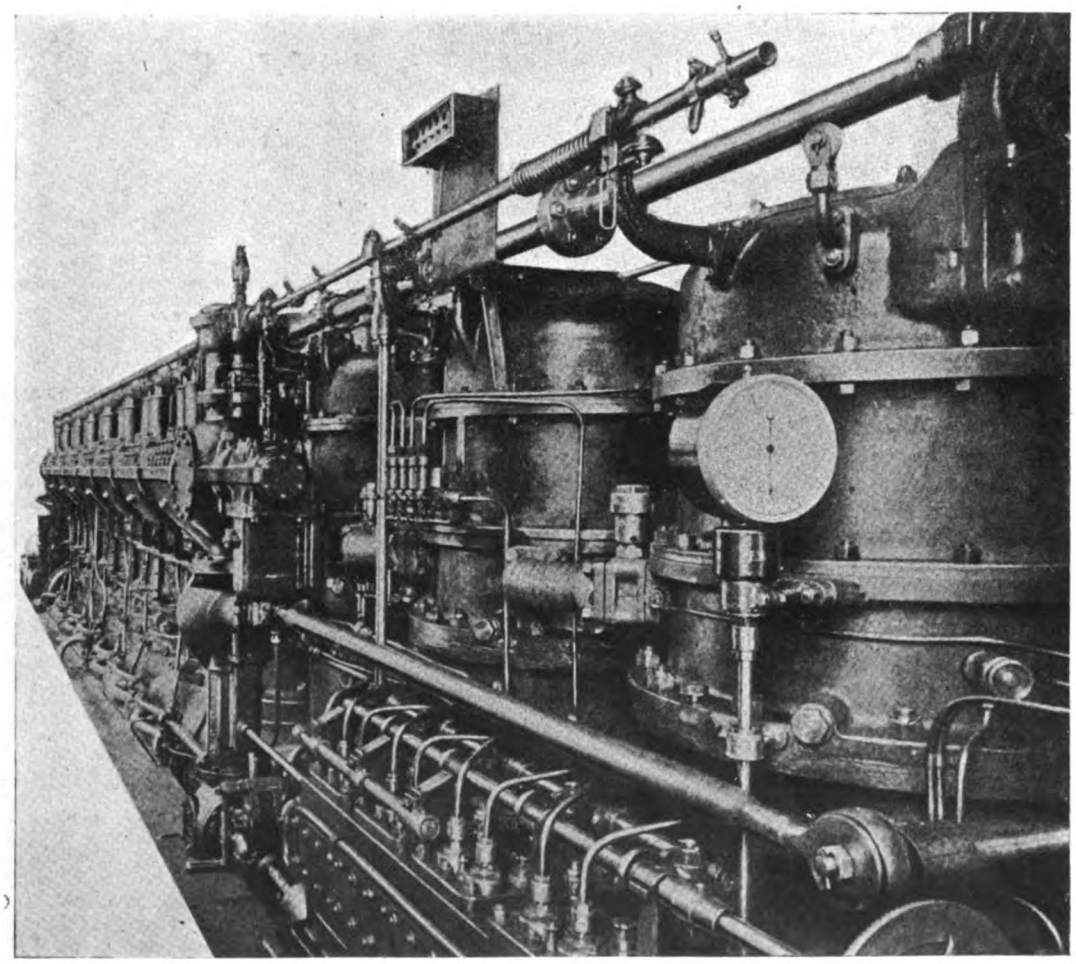
Schneider's largest two-cycle type naval Diesel engines in service are the two installed in the French submarine "Nereide," each of which developed 2,400 b.h.p. (about 3,300 I.H.P.) at 350 R.P.M. from eight cylinders. But, as yet we are not enabled to describe these monster motors. However, in one way the engine we are about to describe is of greater interest because it is of more recent design and so bears all the latest improvements.

The official rating of this new engine is 1,450 b.h.p. at 330 R.P.M. from eight single-acting cylinders, each 410 mm. bore (16.1417 ins.) by 450 mm. (17.7165 ins.) stroke. This, obviously is a very conservative rating, and the engine must have a maximum output of 20 per cent in excess of this figure without danger of trouble developing. A little calculation will show that 1,450 b.h.p. (2,150 indicated H.P.) is developed with a mean-indicated-pressure of 89 lbs. per sq. inch, and a mean-effective-pressure of 60.5 lbs. per sq. inch. At this pressure the mechanical-efficiency would be but 68 per cent. Probably the maximum power of this engine is about 2,500 I.H.P.

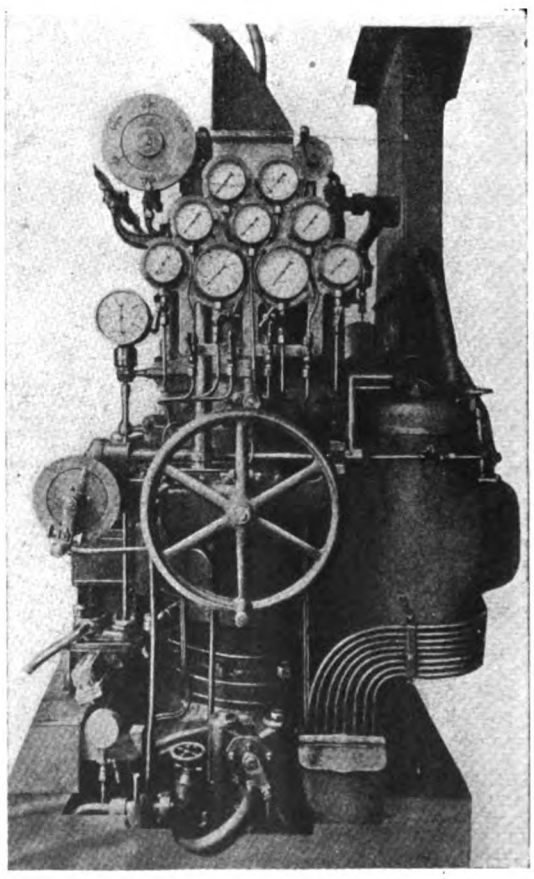
Consequently, four engines of this size at their normal power would drive a combined passenger-cargo ship of 12,000 tons dwc. at 15 to 16 knots average speed, if we allow about 5 per cent loss of power in the electrical-transmission, and the total fuel-consumption of the ship would be less than 35 tons per 24 hour day. There would be a total surplus power of about 1,700 I.H.P. available for emergencies. Whether its normal speed of 330 R.P.M. is too high or not, is for electrical engineers to decide, and if so, the speed can be dropped to 300 R.P.M. and the M.E.P. increased at least 10 per cent, so that the power will be but little affected.

The length of the engine overall is about 30 ft. Its height from bottom of bed-plate to top of valves between 9 and 10 ft. and its width equally moderate, being about 4 ft. These dimensions while not quite exact, will give a good idea of the remarkable compactness of the designs. From the position of the control-wheel shown in the photographic illustration of the end view it will be seen that the engine from the crankshaft center to the cylinder heads is only a little higher than a tall man.

The engine is of the valve-in-head scavenging two-cycle type, with trunk pistons. These pistons are made in two parts, the upper part being of steel, and is oil-cooled thro' telescopic tubes, these having knuckled joints. At the forward end of the engine are three combined scavenging-pumps and air-compressors, and these are driven directly by



The 2,150 I.H.P. (1,450-1,600 b.h.p.) eight-cylinder Schneider two-cycle reversible naval Diesel engine



Forward end view of the 2,150 I.H.P. (1,450-1,600 b.h.p.) Schneider Diesel engine. The position of the control-wheel denotes its small size for its power

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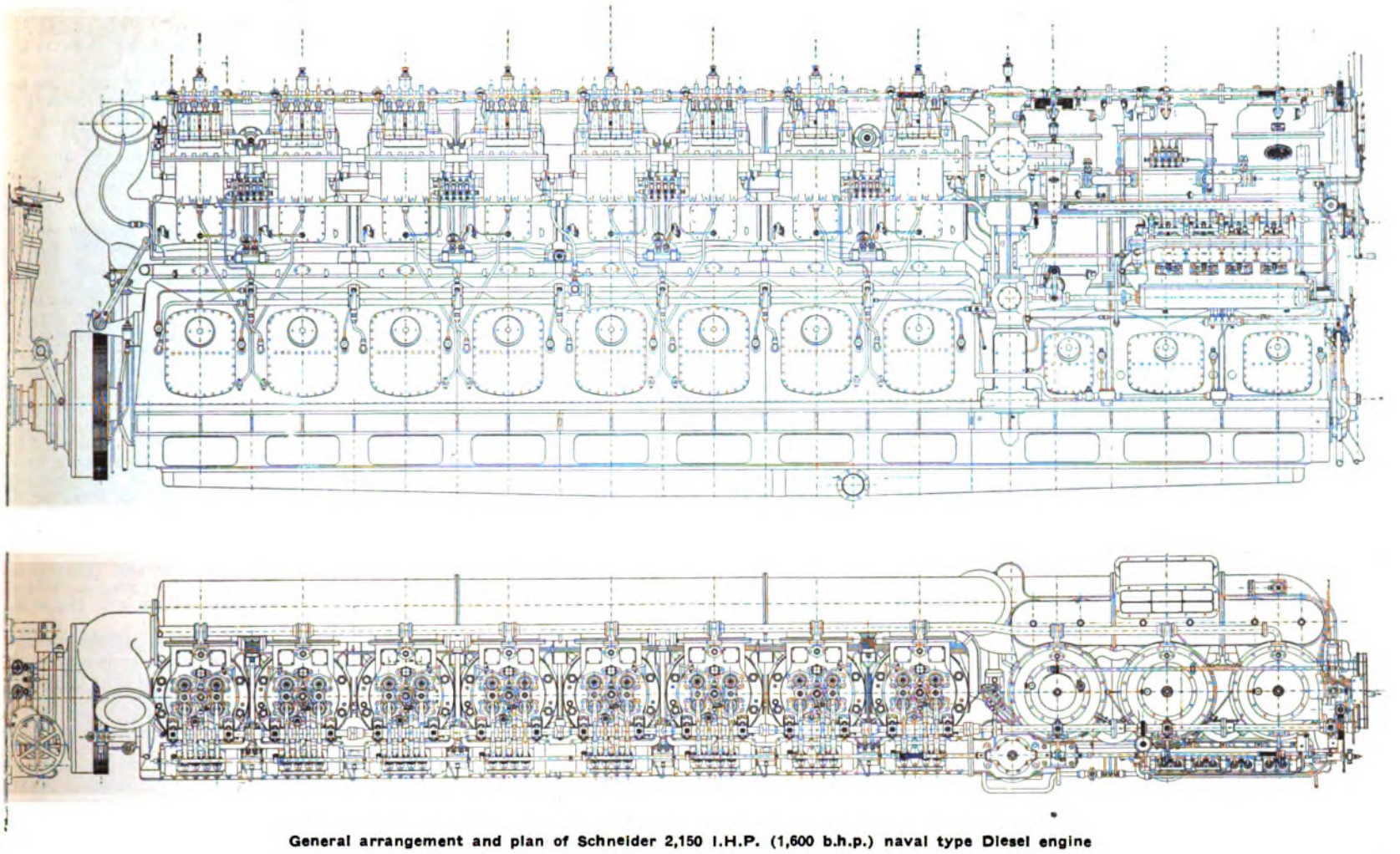


General arrangement and plan of Schneider 2,150 I.H.P. (1,600 b.h.p.) naval type Diesel engine

the crankshaft. Between the forward working-cylinder and the air-pumps is arranged the vertical shaft that drives the camshaft and the governor. There are four scavenging-valves per cylinder.

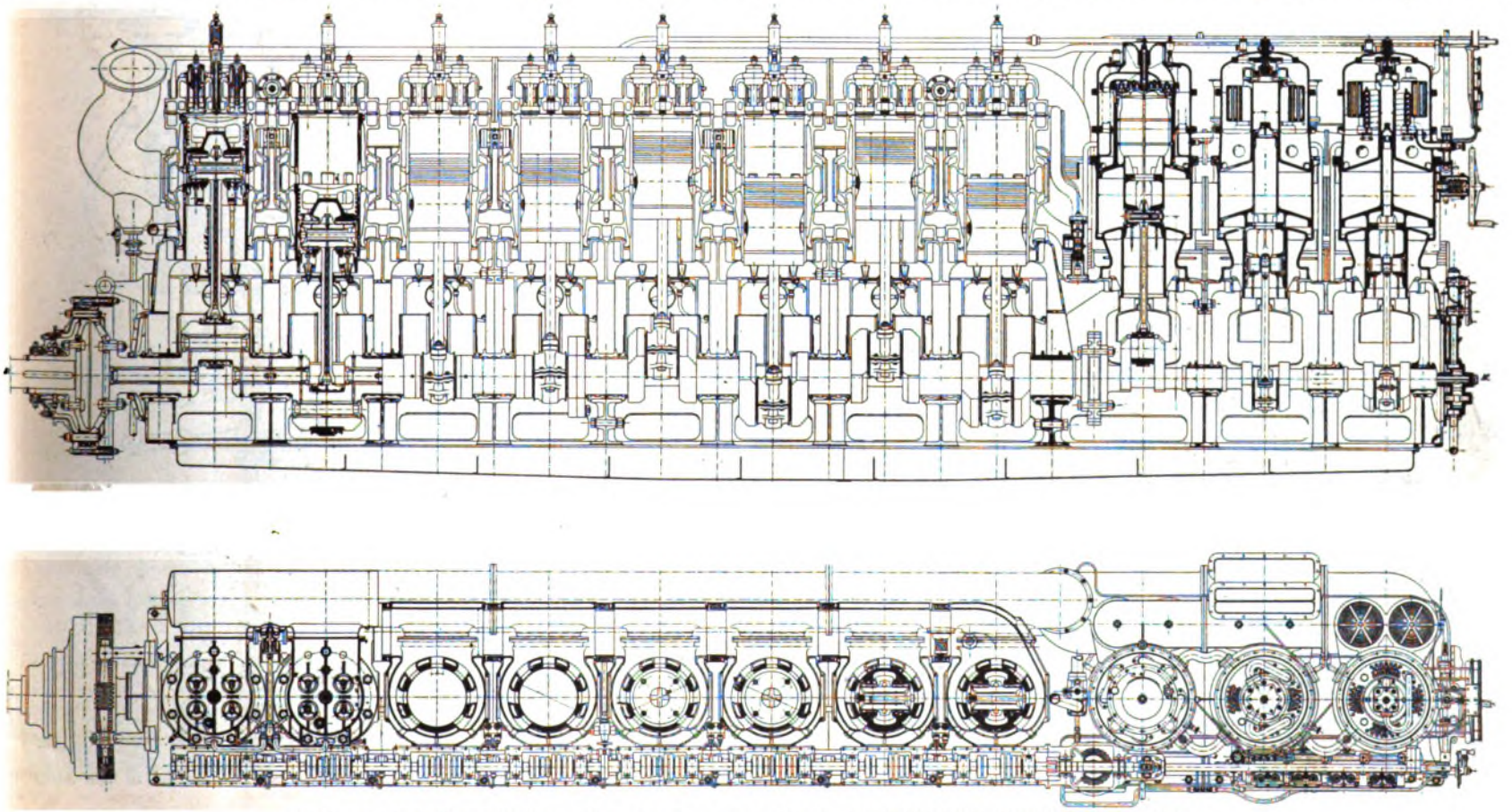
The bed-plate and frame are crucible steel castings; the cylinders, which are cast separately are of cast-steel with a cast-iron liner. The cylinder-cover is a steel casting.

As regards the arrangements for starting, stopping and reversing, the engine has been made direct-reversible with the idea that a submarine when carrying-out necessary manoeuvers can go alongside the dock, etc., without utilizing the electric motors. But, of course, with a Diesel-electric driven cargo ship the engines could be reduced in first cost by dispensing with the direct-reversing mechanism, and so use the electric motors for the astern motion.

With this engine there are two cams on the camshaft for each valve, one for ahead and the other for astern. The rocking-arms are also under the action of cams fitted to a distribution camshaft, different from the main cam-shaft and parallel to the rocking-arms, and these cams are adjustable, so that, in certain positions, the rocking-arms are completely released from the main cams.

The fuel-valve chamber is provided at its lower part with a ball-atomiser, and with a multiple-hole sprayer. The atomiser distributes the fuel uniformly in the air injected, whilst offering but a small resistance to the air flow, by reason of the round shape of the balls. On the other hand, the multiple-hole sprayer allows the mixture to be delivered in the right direction, so as to distribute it uniformly into the compression chamber, and preventing its injection upon any one part with attendant detrimental effects.

The arrangement is shown in detail in the sketch. The needle is in the center of the cylinder-head on a line with the cylinder axis, and is completely enclosed in a box comprising mainly the needle-seat inside which a brass casing drilled for the air flow forms a guide for the needle at its lower part. The casing is under the constant



Sections of working-cylinders and scavenging pumps of Schneider 2,150 I.H.P. (1,600 b.h.p.) naval type

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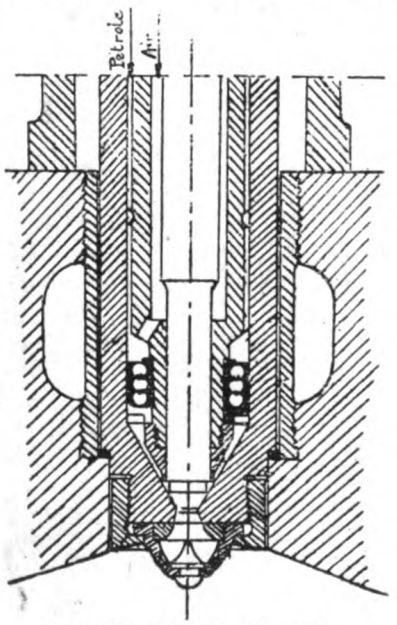
action of a spring which has its bearing on the outside and tends to bring it always towards the lower cone of the needle box. A dividing cone and the ball-atomiser are fitted near the lower end of the casing.

It will be seen that by adjusting the cams on the distribution cam-shaft, certain valve-levers will be disengaged whilst others will continue to be in contact with their main cams, so that according to the distribution required it is possible, on starting, to put all the cylinders (or a sufficient number of them) in communication with the compressed-air admission, and then to cut off the air from one or several cylinders, supplying with fuel one or more cylinders as required. The adjusting of the distribution-cams is carried out by causing the maneuvring-shaft to revolve, and one complete turn of the shaft, by hand, by means of a reducing-gear is sufficient to start the engine running without special attention of the operator.

In the position attained when the engine is at a standstill, all the rollers of the valve-levers are free, so that in order to cause the engine to run from ahead to astern, it is only necessary to move the distribution cam-shaft longitudinally, so as to place the cams for astern running under the rollers of the valve levers, when the engine is started running as stated above. This operation, which takes only from 10 to 15 seconds, is effected by turning successively two small hand-wheels placed side by side. A safety device prevents the main cam-shaft from shifting longitudinally until the other cam-shaft be placed in the stop position. The whole device is remarkably safe, and we are advised that no accident of any sort has occurred since it was adopted.

The exhaust, air-admission, and starting valves

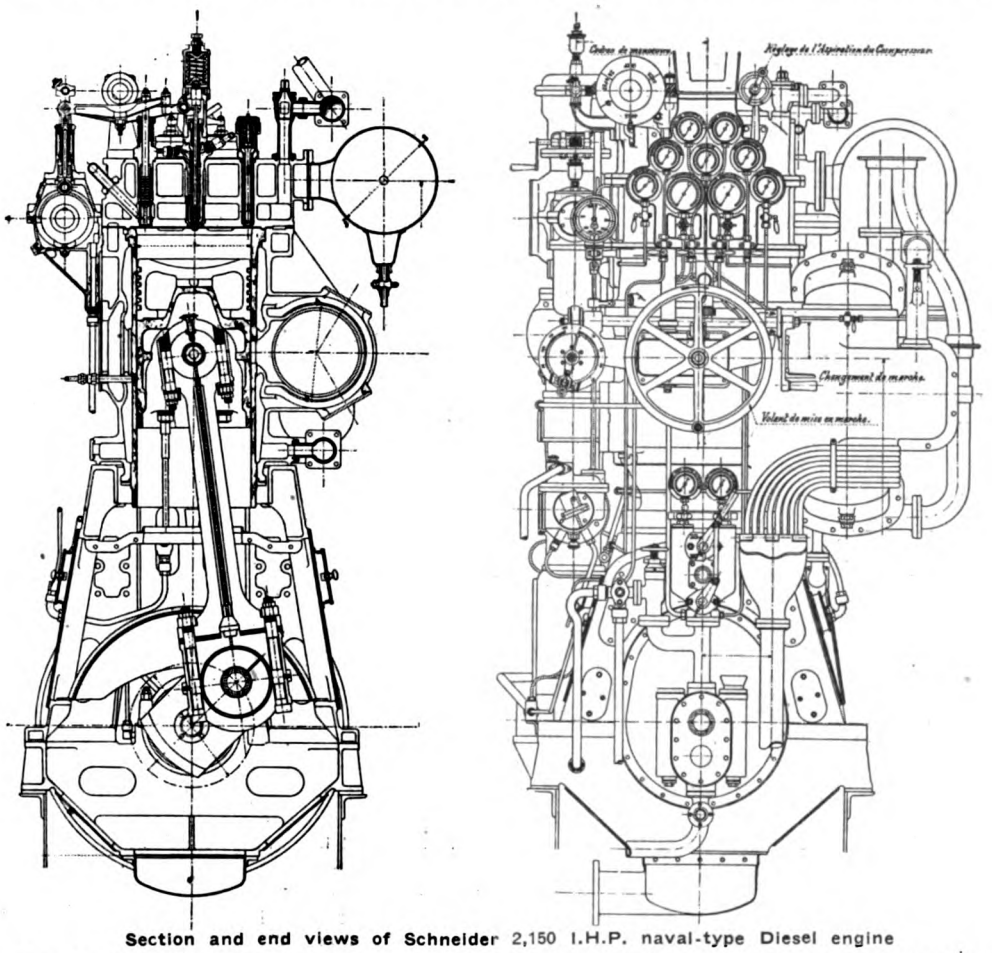


Schneider fuel injection valve

are of the ordinary poppet pattern, except that they are provided with a special device to prevent them from falling into the cylinder if their stems happened to break. The fuel, or needle, valves (the metal employed is specially treated for high temperature), are either of the usual type, i. e., direct effect valves, with straight needle acting in a packed guiding chamber, or of the Swedish type —that is to say—balanced and actuated by rotation.

The oil-fuel reaches the space between the casing and the box by longitudinal grooves made on the casing, and which lead it uniformly to the atomiser. When the needle is in the open position the air drives forward the fuel in the atomiser, through the dividing cone where it is finely atomised, and injects it into the cylinder through the multiple-pole sprayer, which distributes it equally into the air of combustion. All the different proportions of the injection valve and of the atomiser were fixed after long and very careful experimentation.

We now come to the fuel pumps. There is a



Section and end views of Schneider 2,150 I.H.P. naval-type Diesel engine

separate pump for each cylinder. Each oil-pump is governed by causing the stroke of its suction-valve to vary, and the special feature of the device allowing of this variation is the following:

(1) Governing by hand;
(2) Governing by the distribution cam-shaft;
(3) Governing by excess of speed.

The hand-governor, which travels on a graduated section, serves to govern the speed or the load. Governing by the distribution-shaft, takes place when starting for running ahead or astern, so that the pumps commence working only at the required moment. The speed checking apparatus acts to prevent the engine from racing and its action is most effective. A fuel-pump with its governing and operating device is illustrated in the sketch.

A pump set consists of a brass casing, which is common to the various pumps and forms an oil suction tank. A pipe in the tank ending under each pump barrel allows the evacuation of air at each filling up. The pump barrel, of forged brass, is built up on the upper, straightened surface of the tank.

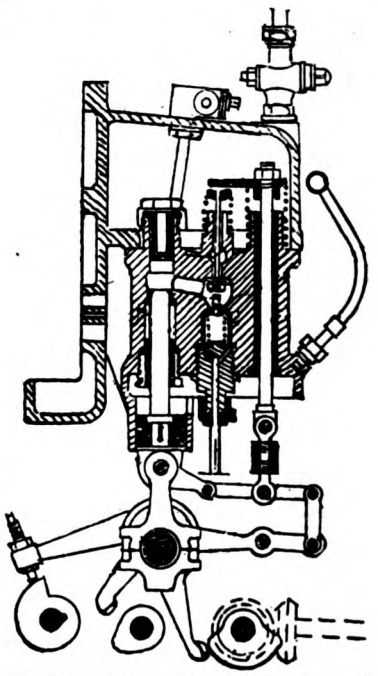
Each pump barrel has a vertical plunger piston of special steel provided at its upper part with a fork which slides in a guide. The piston is operated by a connecting-rod and crank. It draws in an inlet chamber in which operates a long flap valve, the opening of which is more or less prolonged under the action of a contact rod. The working of this rod at the top part of the barrel is under the action of the motion of the piston, and varies as regards travel and time, the variation being obtained by the combined action of a system of knuckle joints and three cams working on three contacts.

Of these three cams, the spiral shaped one is that for hand governing. The cam connected with a sector of over 90 degrees having the same radius, and under the action of bevel-pinions is the cam for governing by the distribution-shaft; it is this cam which automatically stops the pump when the corresponding cylinder runs on compressed air. Finally, the cam of the speed-checking device which occupies a position between the two preceding ones, comes into play under the action of the ball governor, as soon as the speed exceeds a given maximum limit.

The duty of these different cams is to act separately or additionally through the intermediary of the knuckle joint system for the displacement of the rod, and thus to govern the extent and period of lift of the long flap-valve on the oil-suction side, through which flap-valve there takes place a partial flow of oil back to the tank. This action has a direct influence upon the quantity of fuel delivered through the delivery-valve to the atomiser. The delivery-valve is at the upper part of the pump barrel, between the plunger and the rod operating the suction valve. The amount of fuel injected at each stroke has to be exactly that necessary for one combustion phase, for the corresponding load on the engine. These pumps which thus act for the governing of the engine have to counteract a pressure which is much less than is usually the case, owing to the perfection of the ball-atomiser; their delivery has also to be variable within wide limits whilst remaining small in size.

As regards the scavenging-pumps, they have "Hoerbiger" valves because of their high speed. The valves are operated by eccentrics fitted on the main cam-shaft. A sliding-sleeve having a catch allows the cam-shaft to move longitudinally for running ahead or astern, without interfering with the eccentrics.

Before concluding this article we will mention that at a banquet given on January 17th, 1919, at the Hotel Continental, Paris, to American Engineers in France, Mr. Gibbon Spillsbury, President of the American Society of Mining Engineers, announced that Mr. Eugene Schneider, the "Gerant," i. e., principle-owner, of Schneider et Compagnie, Creusot and Paris, had been awarded the highest Gold Medal of the Mining and Metallurgic Society of America, in appreciation of the eminent services rendered by him in the advancement of science and development of metallurgy. In making the presentation, Mr. Spillsbury mentioned that this was the first time that this award had been made to any man other than an American, and that if Mr. Schneider cannot come to U. S. A. for the presentation a special committee will go to France for that purpose.



Schneider fuel pump and governing mechanism

NEW OIL-ENGINE WORKS OPENED IN SEATTLE

On January 28th, 1919, the new heavy-oil engine works of the Gulowsen-Grei Motor Company were opened in Seattle, approximately $750,000.00 having been invested in the factory and equipment. At these works will be built the well-known and successful Gulowsen-Grei-engine as manufactured by A. Gulowsen of Christiania, Norway. A complete illustrated description of the plant will appear in the April issue of "Motorship."

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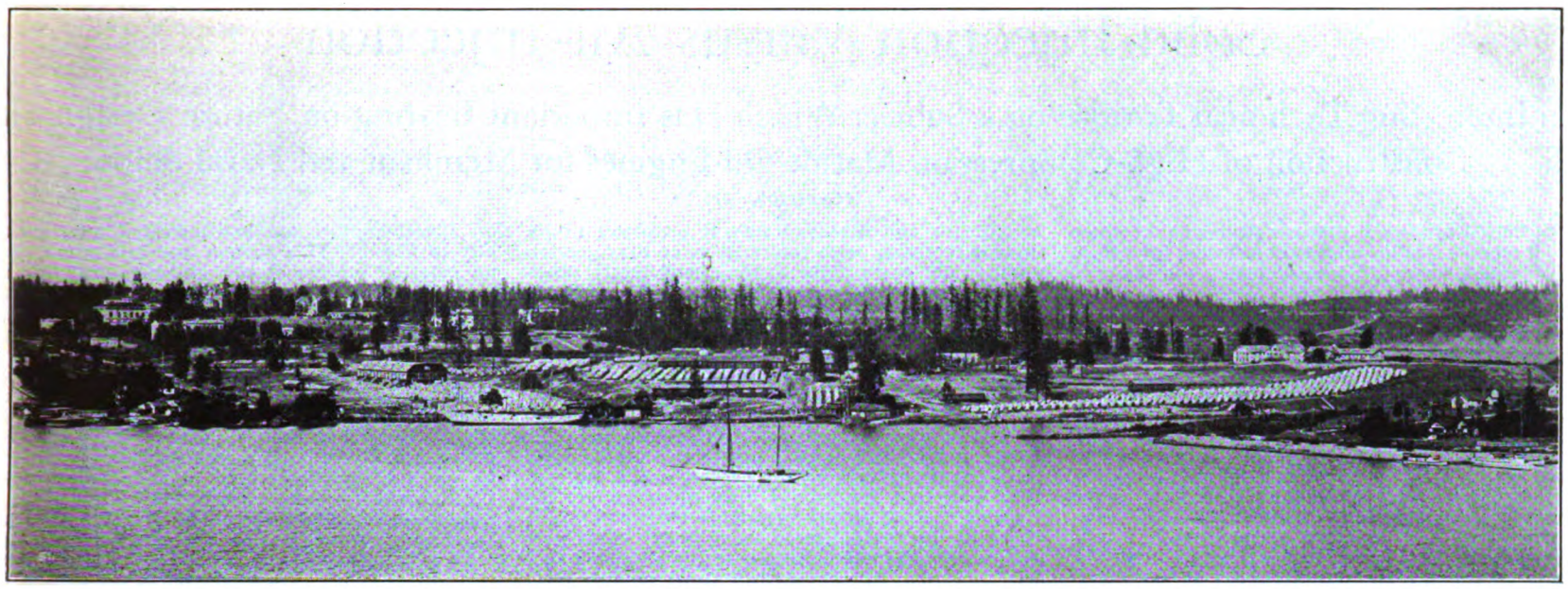
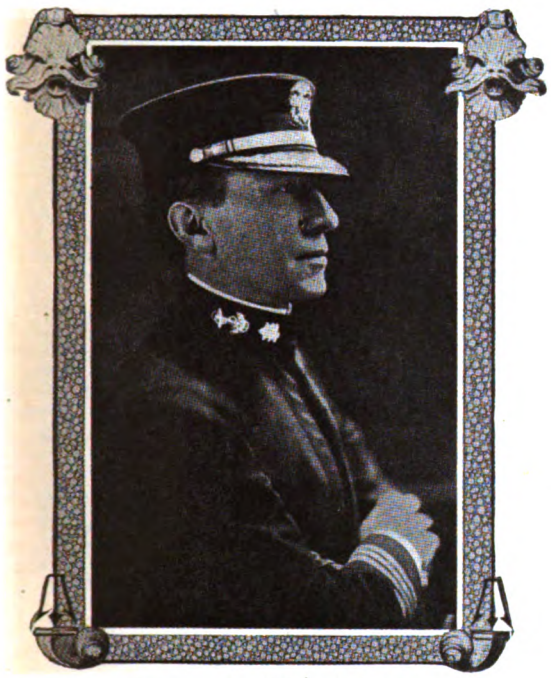


The Naval Training Station at Seattle, Wash.



Commander Miller Freeman

SPLENDID WORK ACCOMPLISHED BY COMMANDER MILLER FREEMAN DURING THE WAR

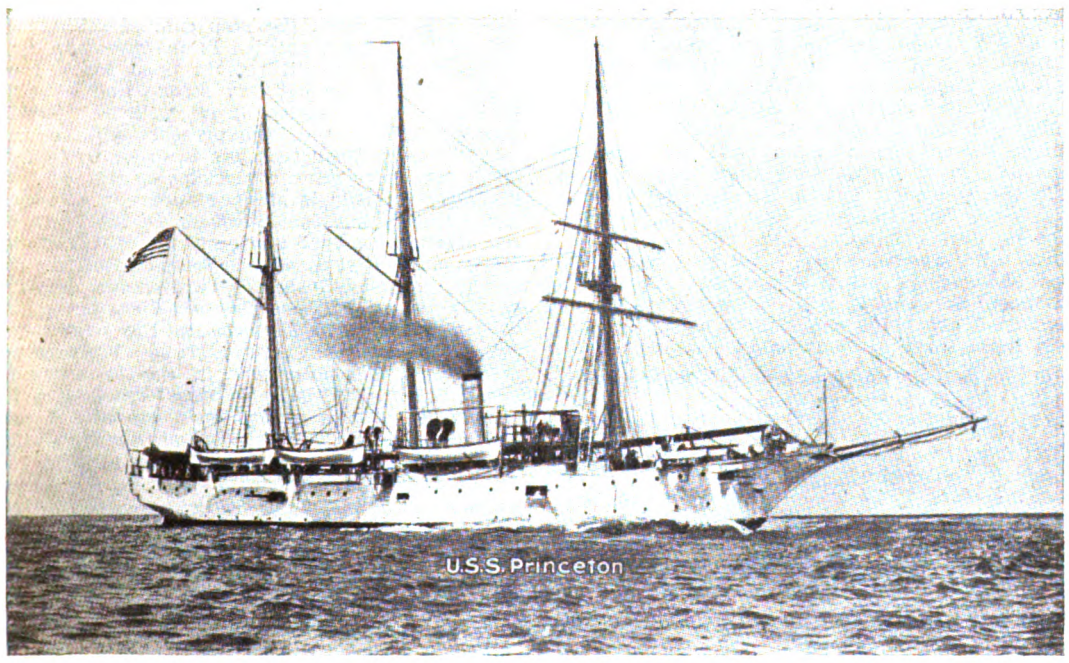
It is somewhat with fear and trembling that we take up our pen, because we know that what we are about to write will bring upon our humble head the wrath of the owner and publisher of "Motorship," namely Commander Miller Freeman, who at the time of America's entry into the war entirely dropped all his various business connections and gave his sole services to his country. But, the "Chief" is of modest disposition, and we know that bringing his splendid deeds into the limelight will cause him to send a powerful tug to tow us on the carpet of his private sanctum and there heap coals of fire on our head.

MILLER FREEMAN has been in command of the Naval Training Station at Seattle, Wash., which he has developed and organized to a remarkable state of efficiency, and at the time of the armistice had 6,000 men in the camp. As far as we know, he was the only man to go from civil life to a position of such importance in the navy. With devotion, energy, tact, imagination, and efficiency he built up the naval training-station to one of the most important in the United States, conducted a vast business and educational organization, and most emphatically "delivered the goods" in the shape of well-trained men for the navy. Thousands of these young men brought here from near and far, are now scattered all over the world on American war vessels, giving service to their country. And, every one of these young men constitutes a credit mark for the commandant of the station.

Since his retirement from active duty Commander Freeman has been appointed by Governor Ernest Lister to serve as the head of the Veterans Welfare Commission, which will have charge of the relief work for returned soldiers and sailors. A fund of $500,000 has been placed at the disposal of the Commission.

Knowing what he has accomplished in this direction, we hope that Commander Freeman feels proud of his publication "Motorship," which he founded less than three years ago, and which journal while he himself has been doing so well for the navy, has done so much for the future success of America's merchant marine. He has just returned to civil life and we can see him utilizing his remarkable energy to making "Motorship" the greatest marine publication the world has ever seen, and we welcome his clear eye and steady hand back to the wheel of this ship once more, knowing that he will steer a true and swift course through fair and foul weather.

Commander Freeman! the staff of "Motorship" salutes you, and as with one voice shout—Well done!



The training-ship attached to the Station

The 1st Battalion U. S. Naval Training Station, Seattle, Wash. (Miller Freeman, Commander) marching through the streets of Seattle

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Solid-Injection Versus Air-Injection

An Interesting Technical Treatise on a Subject Which Has Important Bearing on Future Design and Construction of High-Compression Marine Oil-Engines for Merchant and Naval Ships

(Contributed)

OWING to the peculiar conditions under which vessels of the merchant service have been called upon to operate, during the last two or three years, due, of course, to the unrestricted submarine campaign, the attention of shipbuilders and owners has been increasingly attracted by the creditable performances of various motor-driven vessels. There is no necessity to enlarge upon these performances, as "Motorship's" readers have had the figures put before them from time to time. It is interesting to note, however, the way in which many shipping people have begun to realize that there are such things as ocean-going motor-vessels. Large full-powered steel motor-vessels such as the "Jutlandia," "Sebastian," "Oregon," "California," "Juno," etc., and auxiliary-powered sailing vessels such as "La France" are certaining emphasizing the advantageous performances of motor-vessels, and there are some American wooden motorships doing excellent work.

The advantage gained by the motor-vessel is in its all-round economy, i. e., cargo space, fuel-consumption, operating costs, etc. It is not within the scope of this article to deal with the proofs of this statement which are to a large extent acknowledged facts. If this economy is so marked, however, it is a natural question to ask—"Why has motor-vessel not been built on a much larger scale than as at present." Prejudice, however, dies hard and as in the cases of all new things it has had to be introduced in the fact opposition. At first there was some reason for the delay, as the Diesel-engine was a most complicated and wonderful piece of mechanism needing careful attention and capable of doing many weird things. This stage however has been quickly left behind, so much so in fact, that the Diesel-engine of the present day is as easy, and in some cases, easier to operate than the usual steam reciprocating sets.

One item which has not evolved to any great extent is the system of injecting the fuel, this still being done generally by high-pressure air supplied by a compressor on the engine. This air-compressor is still a liable source of trouble due to the high-pressure it must deal with (900-1200 lbs. per sq. in.) and also to the fact that the compressor must be running continually along with the engine. To eliminate the compressor necessitates alteration to the fuel-injection system, and the desiging of some means of pulverising, or atomizing, the fuel and of injecting it into the cylinder without the use of compressed-air. Several attempts have been made to accomplish this, of these two, only can be said to have had any appreciable success. I refer to the Brons system and to the Solid-Injection system, and it is with the second of these two systems that I wish to deal.

The purpose of this article is not to prove that the solid-injection engine is either better or worse than the air-injection system, but rather to show how the solid-injection engine has been evolved from the time of its conception, and to show what advantages and disadvantages it possesses in its up-to-date design with reference to an air-injection engine, and so to allow anyone, sufficiently interested in the subject to decide for himself which system is the more advantageous.

For the purpose of comparison therefore, and before dealing with solid injection a brief description is given of the typical air-injection system shown diagramatically in Fig. 1.

Oil is drawn from the main fuel-tanks and delivered to the service tank by a small hand or power pump. This tank is placed at a higher level than the fuel-pumps on the engine, and it is from this tank that the pumps draw their supply delivering the oil to the underside of a non-return valve in the fuel-injection valve body. This non-return valve is not indicated in the arrangement; but, is fitted to prevent the injection-air from blowing down the fuel-pipes. At the same time a high-pressure air-compressor is delivering air to the fuel-injection valve at a pressure of 900-1200 lbs. per sq. inch. Inside the fuel-valve body and close to the valve seat is a pulverizer, this is a specially constructed detail, and as the fuel-valve is lifted, the injection-air drawing with it a certain amount of oil from below. The non-return valve passes through this pulverizer, and through the flame-plate into the combustion space. In passing through the pulverizer the oil is efficiently atomized, and used with the air as to render combustion easy and efficient. The flame-plate serves to spread the oil entering the combustion space, and to so produce more even combustion. The air-compressor must, of course, be supplied with inter and after cooler and separator, if efficient and economical operation is desired.

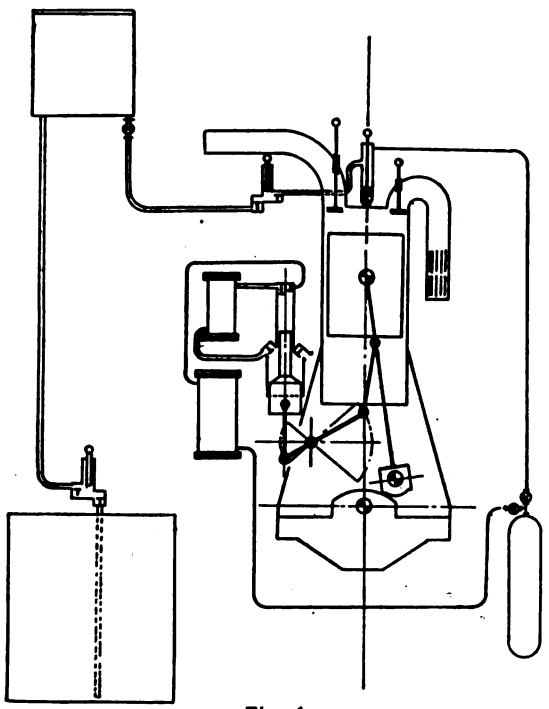

Fig. 1

Now in a solid-injection engine the oil is delivered from the high-pressure pumps at a pressure of from 3000-4000 lbs. per sq. inch direct to the fuel-injection valve in the cylinder-head. In this valve there is the pulverizer or flame-plate, and a specially constructed nozzle, acts both as a pulverizer and sprayer; hence, when the valve is lifted the oil by means of this high-pressure forces its way into the combustion space by way of the valve nozzle. This is a very brief description of the solid-injection system, but it must suffice for the moment.

Now solid-injection was I believe first introduced about eight years ago, since that time I have been acquainted with these separate systems which are to be the subject matter of this paper, these three systems being:—

(1) Separate pump and accumulator system.
(2) Measuring valve system.
(3) Balanced pressure fuel-valve system.

Now, it will be understood that in each of these systems some modifications would have to be made, therefore I propose dealing with each system separately, to show how it was first designed, and to give the modifications in the order that they arose, and thus bring each system up to date before going on to the next system.

SEPARATE PUMPS AND ACCUMULATOR SYSTEM

This is the system which was first introduced on Diesel-engines and is illustrated diagramatically in Fig. 9. This system was first fitted on to an existing engine of the air-injection type, the various parts such as fuel-pump and injection-valves being modified to suit the new system. The engine was an eight-cylinder, four-cycle machine of 800 B.H.P. Referring to the illustration it will be seen that a high-pressure fuel-pump is mounted on the front of each cylinder (one cylinder only being shown). The pump draws its supply from a pipe from the service tank, and delivers it at a pressure of 4000 lbs. per sq. inch to the fuel-injection valve in the cylinder-head. On the way to this valve, however, the oil is in commnuictaion with a pressure regulator, and must pass through a very fine strainer.

To consider the various details and their functions more fully: The fuel system for each cylinder is entirely independent of any other, and if one cylinder is cut out it in no way affects the remainder. The fuel-pump, which is operated by an eccentric off the camshaft, is provided with a mechanically operated suction-valve, and two automatic delivery-valves. In the pump body there is also a cartridge-type strainer through which the suction oil must pass. The suction-valve is operated by a cam and tappet rod from the camshaft. The cam itself being divided into ten equal divisions (Fig. 3a), each division having a different profile, but having the same starting point, thus ten different periods of suction-valve lift can be obtained.

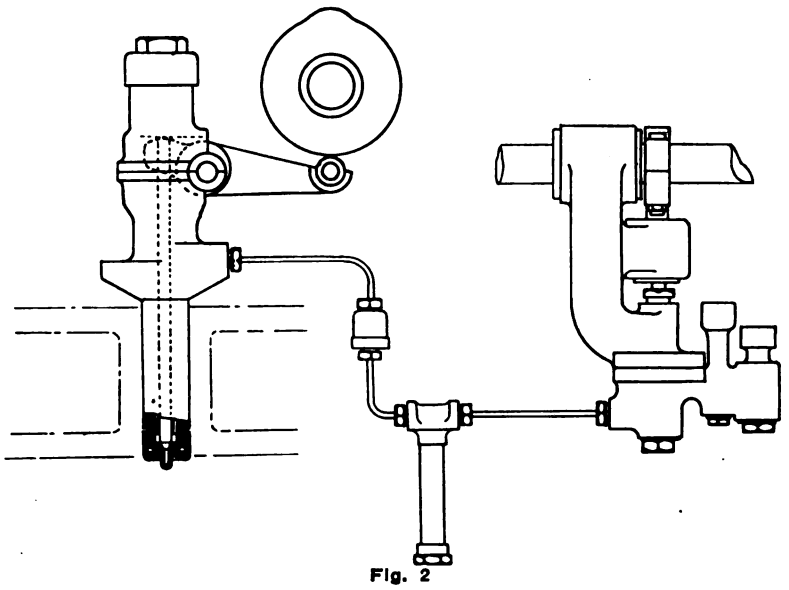

Fig. 2

During normal working the suction-valve opens automatically during the pump suction, and the step cam being in full-power position the valve is kept open only a short period during the delivery stroke of the pump. When lower engine powers are desired the step cam is moved until one of the larger profiles is in operation, when the suction-valve will remain open for a longer period during the delivery stroke and a proportionately less quantity of oil will be delivered. The strainer on the high pressure pipe required to be of special construction, in order to clear the oil of even very minute particles of grit, etc. The necessity for this is at once apparent when it is noted that in the fuel-spray nozzle there are only five small holes, each having a dia. of 0.019 inches. The strainer first fitted was composed of two discs of wire gauze held apart by a distance ring (Fig. 4a), the space between the two discs being filled with a form of hemp packing, the whole being held in place with a screwed ring. The regulator fitted on this engine was in reality a kind of accumulator (Fig. 5a). It was formed of a long tube, fitted with a welded steel cap at the lower end, and open to the delivery pipe at the higher end. The section of the tube being elliptical any excess pressure was spent in bulking out the flat walls of the tube, being returned when the fuel-valve opened and the oil entered the combustion space.

In actual practice these fluctuations could be distinctly felt by the hand, and the tube soon came to be called the pulsating tube. The fuel-injection valve was a modified design of the old air-injection one, and is illustrated roughly in Fig. 2. It will

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be seen that it is of the type having a heavy spring carried in a cage above the valve lever. The space which was formerly occupied by the pulverizer is now taken up by a long sleeve which acts as a guide for the valve spindle. Passages

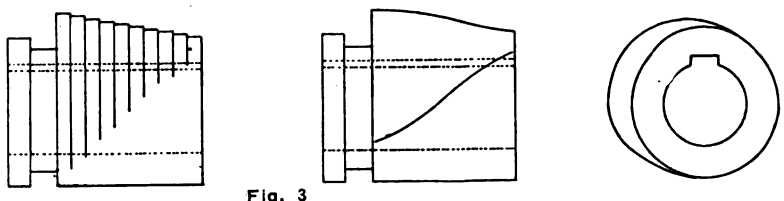


Fig. 3

for the oil from the inlet to the valve seat are cut longitudinally along the outside of this sleeve. In place of the old flame-plate a nozzle was substituted having a spherical end in which were drilled five holes of 0.019 inches dia. These holes were evenly pitched and at such an angle as to ensure of even distribution of the spray round the combustion space. A good deal of experimenting was done with these nozzles before fitting them on the engine, the various nozzles being mounted on a connection and high-pressure oil being forced through the holes the action of the spray being carefully observed. This is the system as it was first fitted and now the more important modifications will be considered in the order in which they occurred.

The first modification was made to the step-cam, for it was found that in attempting to move the cam, when bringing one of the larger profiles into action, the roller was very apt to catch on the flat side of the steps. This made the action awkward and jerky so some easier and smoother working arrangement was sought. The step cam therefore was discarded and a scroll cam substituted for it. This scroll-cam (Fig. 3b) gave exactly the same valve opening periods. Imagine the scroll cam divided into ten divisions equal in width to the steps in the old cam, then the profile at the centre of these divisions is exactly the same as the profile of the corresponding step.

Thus, the scroll cam gives the same openings but instead of a series of steps, it has an even, continuous curve, which will slide evenly and smoothly over the roller. It was necessary to radius the edge of the roller in order to obtain a correct reading. correct positions of the scroll cam were given on a graduated scale. This scroll cam although

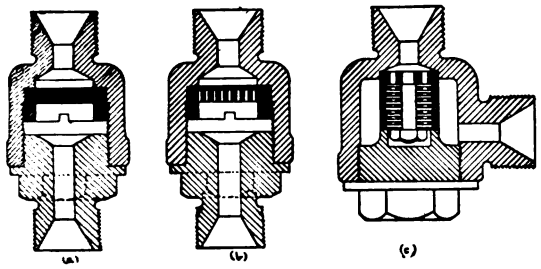


Fig. 4

slightly more difficult to manufacture, had the desired effect and was adopted for future engines using this system. The second modification was made on the regulator, for it was found that any sudden drop in pressure rendered the tube liable to collapse and to fracture. Such a contingency would arise say, if a pipe joint suddenly gave out, or in the case of a fuel-valve "sticking" open. This trouble however was easily overcome, by the simple expedient of fitting a steel bar down the centre of the tube (Fig. 5B), so that although the tube was still free to expand it could not collapse below the normal.

The third point arose on the strainer on the high-pressure pipe. To be effective, of course, the oil passage through the strainer had to be very fine, and as in the case of the one shown the oil was considerably retarded in passing through the strainer, the natural result being a considerably higher pressure was experienced on the inlet side than on the outlet side, so that the wire gauze and packing very soon blew out.

Another type of strainer had to be designed therefore, capable both of cleansing the oil efficiently and of withstanding the high pressure. The type adopted is shown in Fig. 4b. The gauze and intermediate packing were replaced by a brass plate about ¼-in. thick. A large number of holes $\frac{1}{16}$ in. dia were drilled in this plate, these holes however did not quite penetrate through the plate. The remaining metal being pierced by holes of 0.017 ins. dia. The holes in the valve nozzle being 0.019 ins. dia. any foreign matter passing through the strainer, would of course pass through the valve nozzle without choking it at all.

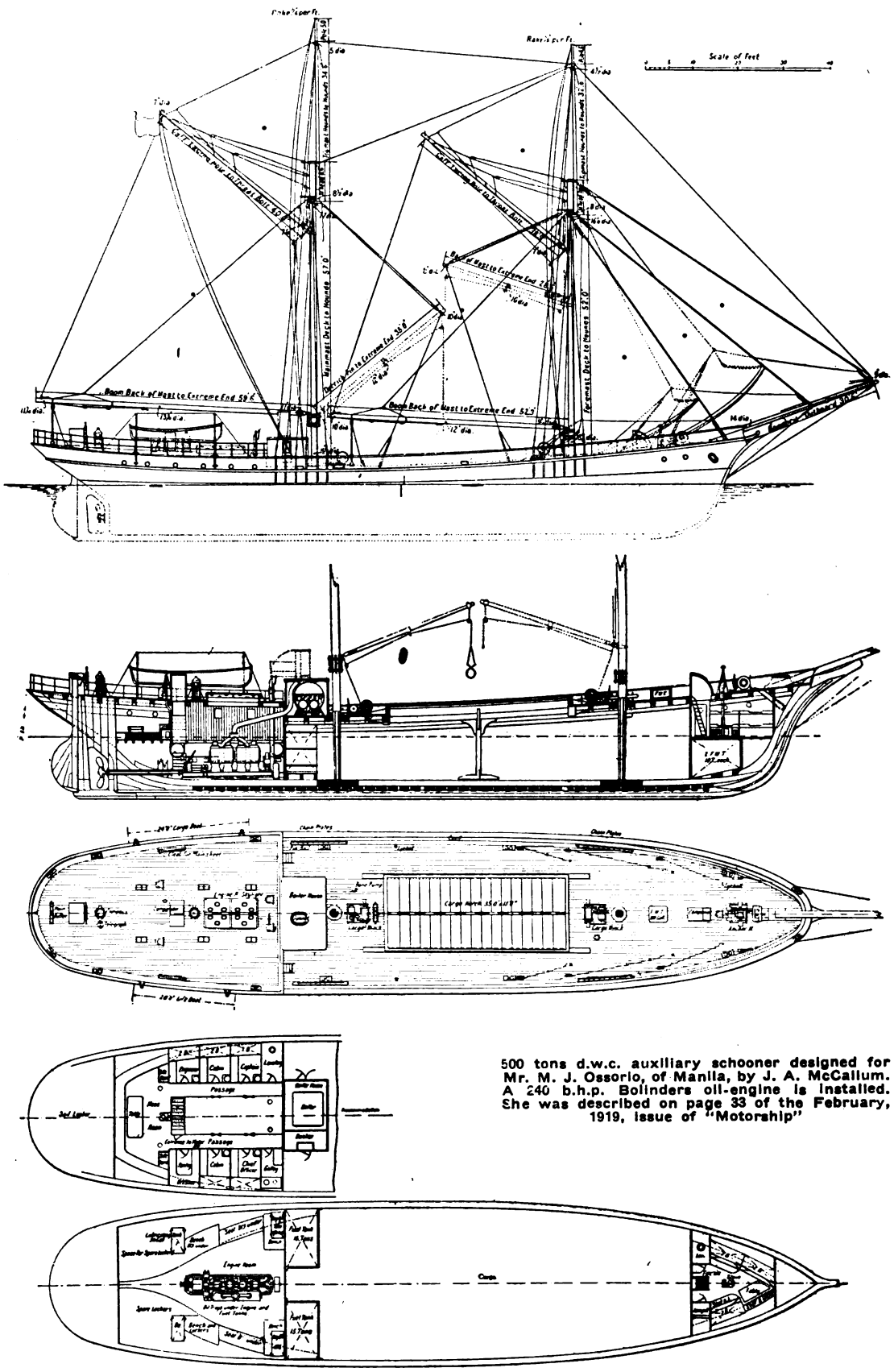
The regulator again came in for modification, this time, however, in an endeavor to lessen the cost of manufacture. The section adapted this time is shown in Fig. 5c, it was only slightly elliptical, the deviation from the true circle being unnoticeable to the eye. The swaging of a tube to such a section being a simple operation in comparison to the previous ones, and as it serves the purpose for which it was designed it is now fitted on engines using this system. Another important point is that the tendency of the tube to collapse is obviated by using a section so very nearly circular.

The final modification was the outcome of experiments conducted on an engine having a different solid-injection system. It was decided that the shorter the distance between the valve seat and the valve nozzle, the better consumption would be obtained and as this distance was rather great in the existing fuel valve it was decided to modify it for this reason. The alteration was effected by allowing the valve-spindle to seat directly on to the valve nozzle. This is not exactly an ideal arrangement owing to the mechanical difficulties, but it served to reduce the length of the pipe about 40 to 50%.

This completes the modifications to this system, but it should be understood that these are only the outstanding points which have been considered.

(To be continued in our April issue when the other illustrations referred to will be given)

Philippine Auxiliary Schooner



500 tons d.w.c. auxiliary schooner designed for Mr. M. J. Ossorio, of Manila, by J. A. McCallum. A 240 b.h.p. Bolinders oil-engine is installed. She was described on page 33 of the February, 1919, issue of "Motorship"

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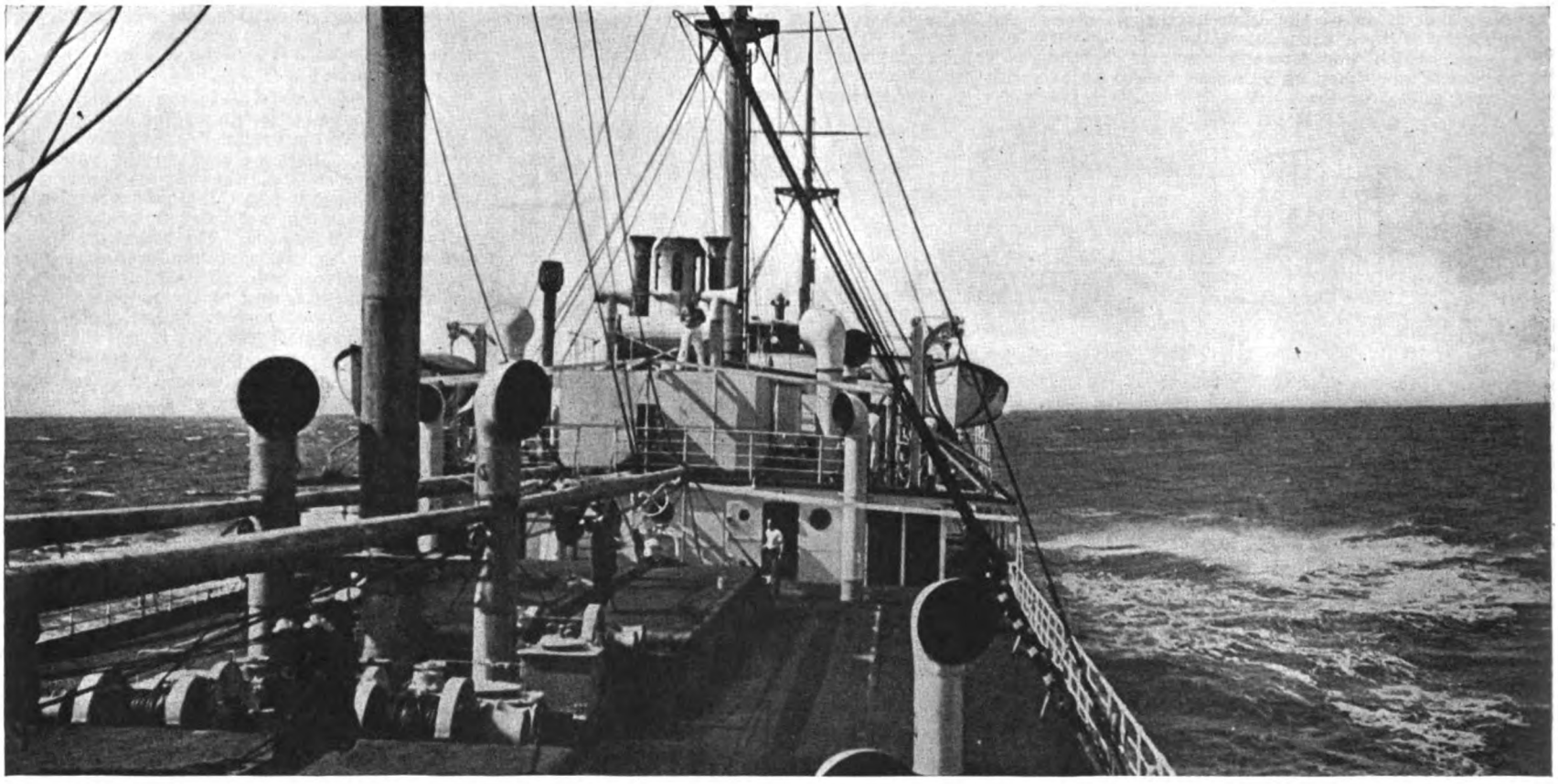

The "George Washington" in mid-Pacific

Performance of the Twin-Screw Motorship "George Washington"

A Trip to the Orient and Return—*Part 2*—Continued from February issue

By HUBERT C. VERHEY

[*Engineer-in-Charge. Marine Diesel Engine Dept. U. S. Shipping Board, Emergency Fleet Corporation*]

(*Published by the Kind Permission of the U. S. Emergency Fleet Corporation*)

MOISTURE and heat conditions have often proven to be the reasons for failures in compressor designs, so that this method employed is a real step in the right direction, and the builders' claim for having an improved compressor is entirely justified, and this design is the only novelty the writer has been able to detect, in comparison with many other designs in other installations, where compressors and main engines of this type are used.

The air entering the low-pressure stage through the mufflers is discharged into the L. P. cooler body, and strikes the cooling tubes, on the way down separating moisture, which is drained in the form of water at the lower end of the cooler, together with some air which is lost as already stated, after which this air is admitted through suction valves into the I. P. stage, from where it is discharged to the I.P. air cooler, which is provided with an ordinary draincock at the lower end.

From here the air goes to the H.P. stage and is cooled in copper cooling-coils located inside of the H.P. head, after which it is led to the injection-air bottles and from there to the fuel valves.

The cooling areas are of adequate capacity to cool the air efficiently, as at no time the temperature exceeded that of the engine room even in tropical waters where the cooling water was as high as 81 degrees Fahrenheit, which is another valuable feature. The sketch will be explanatory as direction of flow of water and air are indicated by arrows and shows the perfect counter-flow system.

The CRANK CASE is entirely enclosed. Portable doors are provided on both sides, giving access to the moving parts. The top is provided with stuffing boxes to secure tightness for the passing pistonrods.

The FUEL PUMP is built out of one solid piece of steel, which contains the suction and discharge valves and the plungers for each separte cylinder. The plungers are operated from a yoke driven by gears from the crankshaft. The amount of oil displaced is controlled by an arrangement which operates and checks the lift of the suction valves.

An ASPINAL OVER-SPEED GOVERNOR is arranged for and lifts all suction valves at one time. thus cutting the fuel supply out entirely in case of racing.

The TURNING GEARS for both engines are electrically driven. The motor drives a horizontal shaft, provided with a worm which in turn drives a worm-wheel located on top of a vertical shaft, which is provided with a worm engaging the teeth in the flywheel. The whole gear is arranged to slide athwartships for the purpose of disengaging when not in use, in which case the vertical turning shaft is moved outboard, together with the motor and all, by means of a horizontal shaft at the lower end of the turning gear pedestal, which shaft is threaded and is provided with a handwheel pulling the whole affair back and forth through guides at will. Provision is made to lock the whole arrangement when not in use.

The THRUST BLOCKS do not need any particular description, as they are of the ordinary marine type, and provided with water-cooling, while proper lubricating arrangements are provided for.

The COOLING-WATER SYSTEM distributes the water as follows:

Two electric-driven centrifugal-pumps take outboard water from the S.B. side, where two sea-valves, one lower and one upper, are located near the forward bulkhead. The sea-valves are both connected to the main suction line, from where they are led to either the port or S.B. pump. One of these pumps is of sufficient capacity to take care of both engines. Each pump is running during two watches, in succession, so that when one is used, the other serves as a spare, leaving chance for overhaul or repair if necessary. The discharge lines are therefore interconnected, and the water enters the system at the lower end of the air-coolers in both engines.

After the water for one engine passes through the compressor, it is divided up to the working-cylinders and to the piston-cooling. The cooling-water for each individual cylinder enters below in the jacket and is admitted into the cylinderhead on the outboard side from where it flows, from the top of the head, through the exhaust valve cage and from there to the exhaust header and overboard. The cooling-water for the piston passes through a telescopic pipe on its way to the cooling chamber in the piston top, from where it flows down through another telescopic pipe to a visible outlet.

A funnel allows inspection, while a thermometer registers the temperature. This water follows its way to the bilges, and is pumped overboard from there. All pipe lines are provided with suitable regulating valves.

The EXHAUST HEADERS are made of cast-iron, and consist of two parts, connected at the middle of the engine.

The actual exhaust-pipe is provided with a large horizontal flange, which serves as a cover at the same time, and is bolted to the top of a through, which thus forms the waterjacket. The exhaust-pipes leading from the valves to the header, as well as the connecting pipes between the two parts, are non-water-cooled, but lagged with asbestos. The cooling-water coming from the valve cages, enters on top and is piped overhead.

The main exhausts are led upward to MUFFLERS, located in a muffler house on the boat deck. These mufflers consist of horizontally arranged cylindrical steel tanks, provided with suitable baffleplates, which act as silencers, and lead the gases to vertical pipes discharging in the atmosphere. The mufflers are lagged with asbestos. They contain a heating coil for fresh water, which is pumped through the coils and stored in a tank located aft of the muffler house, from where it goes to the fresh water system.

The LUBRICATING SYSTEM provides for a forced-feed oil supply, for main bearings, cranks, connecting-rods and crosshead. Two sets of electric-driven rotary pumps are arranged for each set having two pumps driven from the same shaft as the motor, connected with flexible couplings. The oil is drawn from a sump-tank located in the middle of the engine room down in the double bottom, and is discharged into a main header running alongside of the engines on the outboard

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side. It passes through a strainer on the discharge side, this strainer taking care of undesirable solid matter or carbon contained in the oil which might collect in the tank due to the fact that the oil after it has served for lubrication of bearings and moving parts drips down and collects in the bedplate from where it is drained back to the sump-tank, and used over again.

The CYLINDER LUBRICATION is supplied by sight-feed pumps located alongside of the engine on the inboard side and enters the cylinder at the lower end at two places. Suitable oil grooves are provided in the liners.

The ELECTRIC GENERATORS of 60 k.w. are direct driven by three 4-cycle 2-cylinder, single-acting Diesel engines of 12⅝ in. bore and 12⅝ in. stroke, running at 300 R.P.M. These engines are provided with 2-stage air-compressors. Cooling-water and lubricating-oil for their forced feed system comes from the main engine system. The injection and starting-air bottles are located behind the engines on the outboard side. The electric generator sets are provided for. One of these is constantly running, taking care of water and oil pumps and the light. The others are only used in port for the electric winches on deck.

The ICE MACHINE working with sulphur dioxide is motor driven, a reducing-gear being arranged for on the inside of the flywheel rim of which is all controlled direct from the engineer's stand.

A STEAM-DRIVEN AUXILIARY AIR-COMPRESSOR is arranged for as an extreme stand-by in case none of the generator sets were able to run and drive the auxiliary compressor, or in case this compressor proper was out of order. Steam is furnished by the donkey boiler at 100 pounds pressure.

The DONKEY-BOILER is oil-fired, has 100 square feet of heating surface, and supplies steam seat all over the ship. It also supplies steam for a fire smothering system, but it is admitted that this is merely to comply with the laws in Denmark, which call for such arrangement, but do not define its size. The amount of steam available is far insufficient, due to the fact that the volume of the holds is not at all in relation to the capacity of the system.

An electric-driven boiler feed-pump is provided for and located in the thrust-block recess, against the watertight bulkhead.

The BALLAST PUMP is a centrifugal pump, motor driven, and is arranged to pump from all tanks, as well as from all bilges and discharges overboard. A connection is provided to prime these pumps direct from the sea if necessary.

The BILGE AND SANITARY PUMPS are two in number, one serving as a standby.

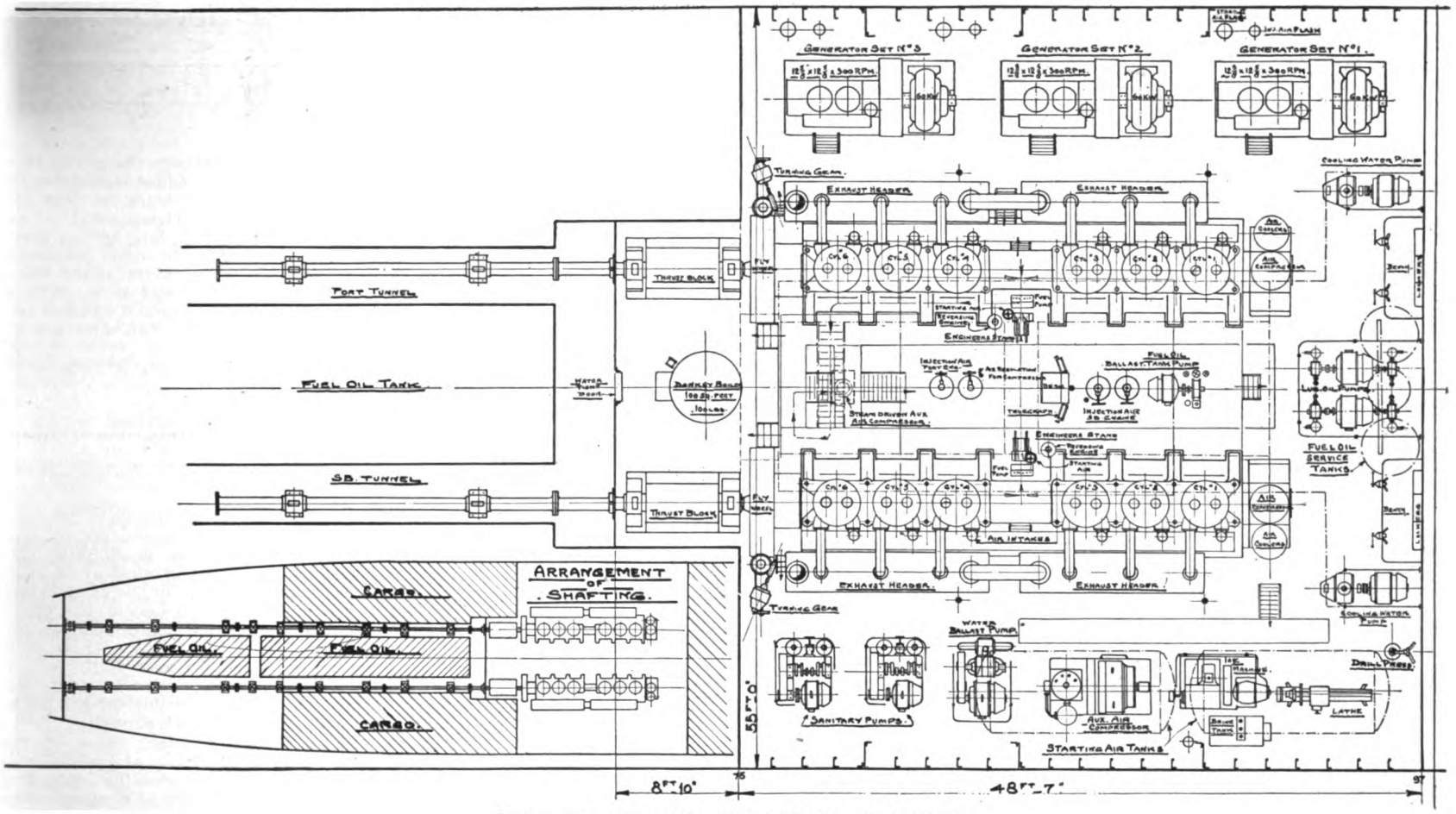
Three steel MASTS of a length of 121 ft. 6 in. to 125 ft. from the keel up, are located from forward to aft respectively. On each side of the masts is a cargo boom post, combined with ventilators with cowl tops. The attachments of the steel CARGO BOOMS are riveted to these posts. Ten five-ton cargo booms approximately 47 ft. long and one boom of 25 tons also 47 ft. long are at hand.

There are six HATCHES—two forward hatches, two midship hatches, and three after hatches. Hatches Nos. 5 and 6 are combined.

Cargo is discharged by means of ELECTRIC DRIVEN WINCHES, eight of three tons and three of five tons lifting capacity being installed. An electric-driven WINDLASS for 2 5/16 in. cable is located forward. Another is located just forward of the after boat deck.

The FORWARD DECK HOUSE contains accommodations, at the shade deck, for steward and stewardess, three cabins with double berth for passengers, and in port occupied by custom officers and a cabin-de-luxe with an adjoining bedroom, toilets, and captain's bathroom, also a pantry and dining-room.

All cabins are beautifully upholstered and the dining-room is particularly fancy, the general color scheme being blue, with mahogany furniture. A stairway leads to the smoking-room at the level of the promenade deck; opposite this room the cap-



Plan of the engine-room of the "George Washington"

tain's quarters are located, these quarters being very luxurious.

The PROMENADE DECK is entirely enclosed by glass windows athwartships at the forward end, also on the sides. Two stairways on both sides of the smoking-room lead to the commander's bridge, where the navigating instruments and the steering-wheel are arranged for.

A CHART HOUSE is located directly aft from the steering stand. This chart house also contains a medicine closet. On top of this house another compass is located. A strong searchlight is located at the portside of the commanding bridge.

The MIDDLE DECK HOUSE has two inside alleys alongside of the engine-room hatch, in addition to two outside alleys. The S. B. side has cabins for all the engineers and the electricians. The portside, for all officers with entrances from the inside only. The cabin of the chief officer has an office attached, which has a door giving access from the outside, and used when the ship is in port.

A dining-room and small pantry for accommodation of the engineers and officers both, is located on the portside, while a common bathroom is located on the S. B. side. A very well equipped GALLEY is located at the aft end of this deck house, while all accommodations described are at the shade deck level.

the compressor. Refrigerating piping is leading to three different compartments in the store and refrigerator rooms.

The AUXILIARY COMPRESSOR is also electric driven and furnished air of 355 pounds per square inch for starting. This air is stored in TWO STARTING-AIR TANKS provided with valves operated from the engineer's stand by means of mechanism, consisting of a horizontal shaft running athwartships, in the middle of the engines, which shaft in turn is provided with sprocket-wheel and chain in order to operate the valves parallel with the centerline of the ship.

The INJECTION-AIR TANKS are conveniently located near the operating stand and are provided with solid steel heads, containing the various valves. Spindles are provided with so-called hammer handwheels, thus securing tightness. Suitable drains are provided.

The STARTING-AIR ARRANGEMENT is controlled from the operating stand. Air from the starting tanks comes through one main, and enters a distributing body, provided with mechanically operated piston-valves, which divide the air to each three cylinders. This air arrangement is interconnected with the fuel pump handling gear, so that the oil is out when starting is attempted, and vice versa. It is posible to start on either three cylinders as well as on all six at one time,

A motor drives a three-throw crankshaft at 80 R.P.M. which operates 3 plungers, doing respectively the following work:

No. 1 discharges piston-cooling water which was led to engine-room bilges overboard. It can also take from all other bilges. No. 2 takes from the sea, delivers to the sanitary system, and gives water on deck or discharges direct overboard at will. Is also arranged to take fresh water from peaks and pumps from one to the other, or discharges direct overboard. No. 3 takes water from all bilges and discharges overboard. The manifolds are located against bulkheads forward and aft.

General Description of Ship:

The "George Washington" is a 9,400 tons D.W. ship.

Length overall	444 ft. 4 in.
Length over deck outside stern and sternpost	425 ft. 5½ in.
Breadth moulded	55 ft.
Depth to shade deck	38 ft. 6 in.
Depth to upper deck	30 ft. 6 in.
Depth to lower deck	22 ft. 6 in.
Frame spacing	26½ in. (in peaks 24 in.)
Camber of beams	13¾ in.
Height of double bottom	44 in.
Length of double bottom	377 ft.

The ship has three steel DECKS, respectively, one lower, one upper, and one shade deck. The stem is straight and her stern is elliptical.

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A boat-deck extends all over the deck-house and the galley skylight, muffler-house and engine-room skylight, as well as the wireless station, with quarters for the operator, are arranged in rotation, as mentioned. The muffler-house contains two muffler tanks as already described. On top of this house a casing is located which contains the smoke-stack of the donkey-boiler, as well as the three exhaust pipes of the Diesel-driven generator sets. Alongside of this casing the main exhaust-pipes are arranged for. Aft of the casing a fresh water tank is located.

Two LIFE-BOATS are arranged for on the boat deck, each boat being capable of carrying 53 passengers. The handling gear of these boats is of a Swedish patent, the so-called Schmidt patent No. 3. One hand-wheel, which is therefore provided with a hand-operated brake, lowers the same at desired speed.

The AFTER DECK HOUSE offers accommodations for the carpenter and boatswain, as well as quarters for two assistant engineers on the shade deck level. On the portside is a lavatory and bath-room, on the starboard side a paintshop and carpenter shop.

A boat deck extended over the whole width of the ship at that part now described offers space for a 22 ft. motor boat and a 17 ft. dingey. A stairway leads to the crew's quarters at the upper deck. Accommodations are provided for twelve sailors and oilers. Two messrooms, one for the sailors and one for the engine room crew are available.

A HAND STEERING-GEAR is located on the extreme after deck and can be connected with the rudder-shaft in case of emergency when the electric steering engine is out of order. The last-named engine will be described hereafter.

The various contents of the holds and the sizes of hatches, also the capacities of the tanks, are marked on the drawing.

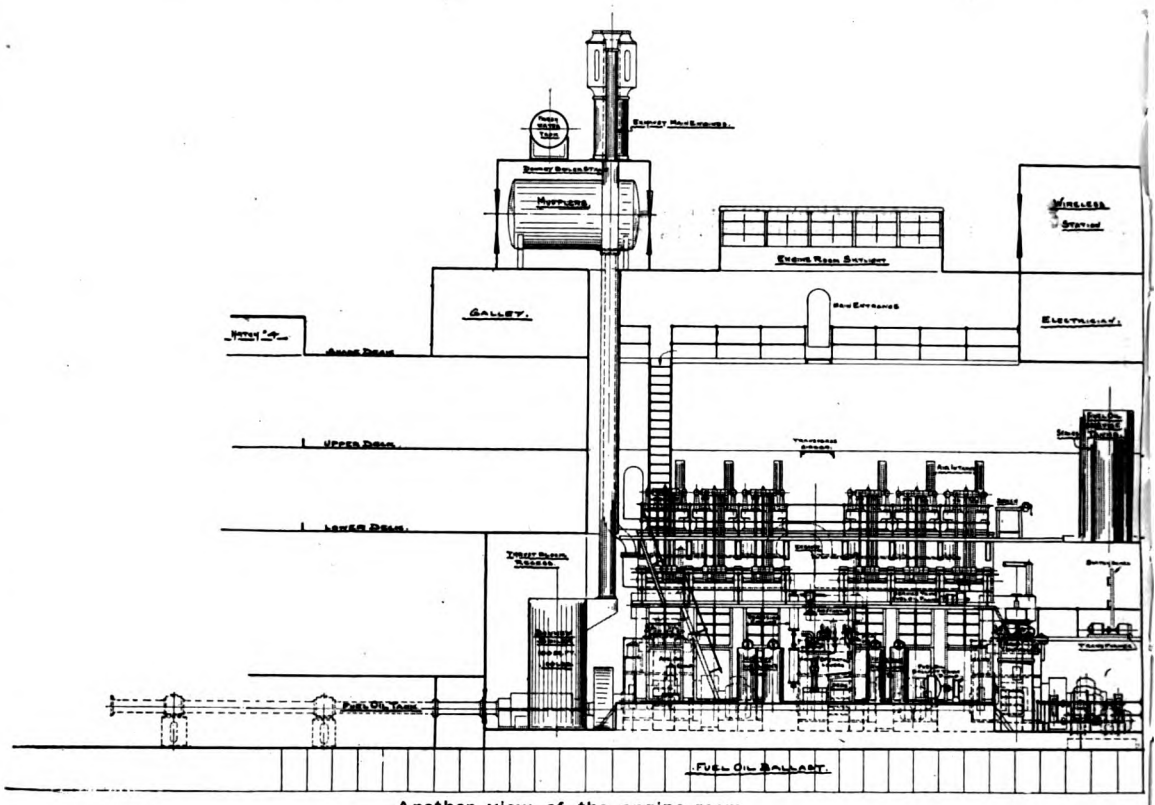
The ship has 7 WATERTIGHT athwartship BULKHEADS as shown in heavy dotted lines on the same drawing. The forecastle head has a steel breakwater. Between the hatches in the holds fore and fat bulkheads are provided.

Particular attention may be called to the CLEATS arranged at the bow and at the stern, which are designed for Panama Canal service. The open end takes the cables, pointing downwards, the closed end is used in case the pulling cables are pointing upwards. In addition, round holes are provided in the railing plates. A STEAM SMOTHERING SYSTEM is arranged for in all holds. A very neat pipe arrangement with manifolds arranged between hatches at the shade deck is provided for; but the capacity of the donkey-boiler having only 100 sq. ft. heating-surface will not prove to be sufficient to be very efficient as the volume of the holds is not in relation to the capacity of the boiler. As already stated before, the ship is properly ventilated throughout by ventilators with cowl tops.

The workmanship can be called first class, while the general design is practical. The upkeep of the ship by her crew is beyond praise.

The ELECTRICAL STEERING-GEAR is located way aft at the upper deck, is manufactured by Hele-Shaw and is provided with a telemotor operated from the bridge. For this a 20 H.P. electric motor is constantly running and is direct-coupled to a rotary oil-pump of variable discharge capacity. The oil is drawn from an open tank and forced into the heads of two horizontally located cylinders. These cylinders are provided with plungers that are connected by a centerpiece, which operates a horizontal arm attached to the rudder shaft.

This arm swings in and outboard while a kind of cross head pivoted at 2 points in the vertical center line slides over this arm which makes the whole construction practically like a knuckle joint which moves the rudder shaft in the desired direction due to the pressure oil admitted at either side of the plungers. While one plunger receives pressure oil, the other is discharging oil into the open oil-tank, whence the pumps take it again for further use. Suitable valves take care of admission and discharge of the oil.



Another view of the engine-room

The Electric Motor is running all the time, while a telemotor controlled by the pressure of a glycerine pump attached to the hand steering-wheel takes care of the turning direction of the rudder shaft by means of a suitable combination of levers, which in turn control the supply at either side of the plungers.

SUMMARY DATA OF TWIN SCREW MOTORSHIP GEORGE WASHINGTON

NAVIGATION								FUEL OIL CONSUMPTION										LUBRICATING OIL CONSUMPTION				
Total Trips		Total per Day			Total per Hour			Total for Trips				Total per Day			Total per Hour			Total per I.H.P. Hour				
Days	Hours	Miles	Highest	Lowest	Average	Highest	Lowest	Average	Auxiliary Machinery	Donkey Boiler	Main Engines	Total Propelling Installation	Total for Trip	Auxiliary Machinery	Donkey Boiler	Main Engines	Total Propelling Installation	Total for Trip	Auxiliary Machinery	Main Engines	Total Propelling Installation	Auxiliary Machinery	Main Engines	Total Propelling Installation
		Miles	Miles	Miles	Miles	Miles	Miles	Miles	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Lbs	Lbs	Lbs
26	5½	6330	279	115	243	11.17	4.82	10.95	12.28	1.97	253.5	270.57	272.54	.47	-	9.83	10.8		.020	.41	.43	.37	.29	.3
6	1½	1736	294	282	285	12.4	11.8	11.9	3.68	.49	61.52	65.15	65.64	.60	-	10.15	10.75		.025	.42	.445	.47	.30	.31
29	6½	6546	287	189	281	11.67	7.88	11.2	10.35	1.48	247.31	257.66	254.14	.45	-	10.63	11.08		.019	.44	.459	.35	.31	.32

.0013 Lbs per I.H.P. = 1/330 of Fuel Oil Consumption.

PERSONNEL

The ENGINE-ROOM PERSONNEL, consisting of 14 men, is tabulated below:

1 chief-engineer (running no watch).
1 first engineer, 1st and 4th watch.
1 second engineer, 2nd and 5th watch.
1 third engineer, 3rd and 6th watch.
3 assistant engineers.
3 oilers.
1 electrician.
2 machinists for general overhauling and repair, working during the day time only.
1 boy for daily cleaning.

The number of men required therefore compares favorably with a force necessary to run steam installations, mainly due to the fact that no firemen or coal trimmers are needed. From observation, however, it appears to the writer that one more electrician should be added because when the ship is in port and night work is done for loading or unloading, an electrician must be on duty to take care of the electric winches on deck, which would bring the total engine-room personnel up to 15 men; but this is not extravagant when we consider the size of the vessel is 9,400 tons D.W. A compromise might be made if at least one of the machinists doing day work had some knowledge of electricity.

The DECK PERSONNEL consists of 22 men, as follows:

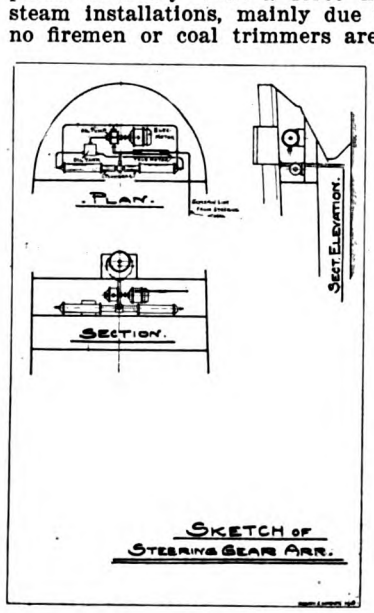
1 chief mate.
1 first mate.
1 second mate.
1 third mate.
1 boatsman.
1 carpenter.
8 sailors.
1 steward.
1 stewardess.
2 cooks.
1 saloon boy.
2 mess boys for officers
1 mess boy for crew.

This would bring the total of the crew up to 36 men. With the added electrician and the captain included, it would therefore be possible to run this size of ship with a total personnel of 38 men.

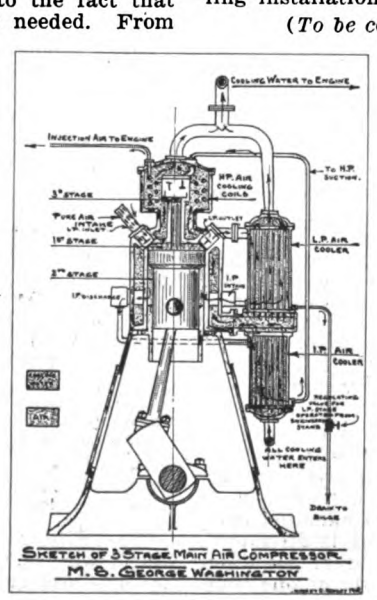
No purser is employed on any of the Norwegian-owned ships as the captain assisted by the chief-mate takes care of the entire administration for loading and unloading of the cargo. These men also are supposed to take the responsibility of the proper loading of the vessel personally, while the chief-engineer is entirely responsible for the maintenance and repairs in the engine room.

The ability and sound common sense of the chief-engineer, Mr. Oscar Mattsson, of Lund, Sweden, adds materially to the success that this propelling installation shows. Under no circumstances could he be moved to speed his engine up beyond the period that safety was at stake, and this really is the only stand to take guaranteeing absolute continuous success for this kind of propelling installation.

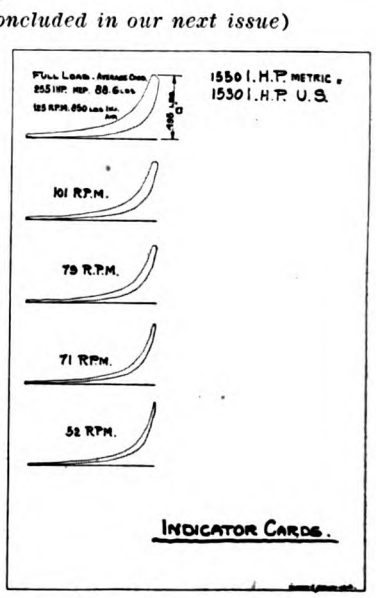
(*To be concluded in our next issue*)



SKETCH OF STEERING GEAR ARR.



SKETCH OF 3 STAGE MAIN AIR COMPRESSOR M.S. GEORGE WASHINGTON



INDICATOR CARDS.

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Interesting News and Notes from Everywhere

BRITISH MOTOR MONITOR WITH PRODUCER GAS ENGINES

The British naval monitor M24, built by Sir Raylton Dixon & Co., is propelled by internal-combustion motors using producer-gas fuel. She was built and placed in service during the war, and is of about 700 tons gross.

BARK CONVERTED TO AUXILIARY POWER

Recently the Italian full-rigged bark, "Nosotra Signora del Boschetto," left the yard of the Morse Dry Dock Company, at Brooklyn, N. Y., where she had been fitted with two Wolverine gasoline-kerosene motors of the electric-ignition type. Unfortunately she was wrecked at the Maternillas Light, n. c. Cuba, during a storm on her first voyage.

PROPOSED 12,000 HORSEPOWER MOTOR LINER

A British contemporary has proposed that the P. and O. Navigation Company shall build a twin-screw Diesel-driven liner of 12,000 H.P. Seeing that the British motor transport "Glenapp" is of 6,600 I.H.P. the project is quite feasible at the present time.

INDIAN 1500-TON OIL-ENGINED AUXILIARIES

At the shipyard of Brunton & Sons, Cochin, India, a 1,500 tons dwc. wooden motor auxiliary is under construction in which two Beardmore 160 b.h.p. heavy-oil engines of the surface-ignition type are being installed. Four sister ships soon will be laid down. American engine builders please send catalogues.

WANTED

Copies of "Motorship" for August, 1918

The publishers of "Motorship" are willing to pay 50 cents each for a limited number of copies of the August, 1918 issue of "Motorship." These copies must be in good condition and before sending the same to the office, a post-card or letter, should be written stating how many copies are available.

FOUR MOTOR LIFEBOATS ON EVERY MERCHANT SHIP

Next July the Merchant Shipping International Convention comes in force, which stipulates that every ocean-going vessel shall carry four motor lifeboats. We advise American manufacturers of small gasoline, kerosene and heavy-oil engines to meanwhile get their motors familiar to shipowners and shipbuilders of all countries without further delay, and not wait until July when the majority of orders for lifeboats of existing vessel will have been placed. There exists no better medium than "Motorship" for such publicity.

NAVAL ARCHITECTS ENGAGE EXPERT DIESEL-ENGINEER

Readers of "Motorship" who follow our Patent Record department with interest each month will be glad to learn that the author, Mr. H. Schreck, has become permanently connected with the well-known firm of Whittelsey & Whittelsey, of New York, as their Diesel and steam engineer. It is a sign of the times, and a denotation of the progressiveness of this firm that they have engaged an expert on marine Diesel-type engines. This should considerably extend their business on consultation in marine work and particularly on motorship questions, especially at a time when such problems are more vivid before shipowners than ever. Mr. Schreck will continue to handle the Patent Record department of "Motorship."

BRITISH SUBMARINE DIESEL ENGINES OF VERY HIGH POWER

The British L-class submarines are of about 950-1100 tons displacement and are driven by two Vickers solid-injection "Diesel" engines of 2,400 b.h.p. each in twelve cylinders per engine, previously referred to in the columns of "Motorship," so have considerable speed. They have been completed up to the L-72. The British K-class submersibles illustrated in our December issue are of 2,600 tons submerged displacement and of 10,000 H.P. As intimated, they are steam-driven when on the surface, having oil-fired boilers and geared turbines. Great Britain also built the MI, a submarine-monitor armed with a 12" gun. The large French submarine Diesel engines are illustrated and described elsewhere in this issue of "Motorship."

BURMEISTER & WAIN & DANISH DIESEL CONSOLIDATED

The New Danish Diesel Motor Works of Holeby, Denmark, and Burmeister & Wain of Copenhagen, have amalgamated. It may be remembered that the first mentioned company was formed by the East Asiatic Co., and the United Steamship Co., as a friendly rival to Burmeister & Wain, also under the same control.

Photo "Syren & Shipping"

Mr. L. G. McFarlane, O.B.E.

A NOTABLE DIESEL-ENGINE EXPERT

The above portrait is that of Mr. L. G. McFarlane, O.B.E., the Engineering-Manager of the merchant-marine and submarine Diesel oil-engine department of Cammell-Laird & Co., Ltd., Birkenhead, England. Under his supervision the new Cammellaird-Fullagar merchant-ship heavy-oil engine has been developed during the war. Previous to joining Cammell-Laird in 1914 he was Chief-Engineer of the submarine engine department of Vickers, Ltd., which was opened in 1900, so his marine oil-engine experience covers many years. Licenses to construct the Cammell-Laird Fullagar opposed-piston type of marine crude-oil engines are being offered to American shipbuilders and engineering concerns.

DANISH CONCRETE MOTORSHIP OF 2,300 TONS DISPLACEMENT

Now building at a concrete shipyard near Copenhagen, Denmark, is a Diesel-driven concrete motorship of 2,300 tons displacement, but we understand that after this vessel is completed concrete ships will be abandoned in Denmark in favor of steel and wood construction because of the high cost of the concrete system. This particular vessel is being built under supervision of the Norwegian Veritas, and about 150 tons of steel have been incorporated into her hull. She has the following dimensions:

Displacement	2,300 tons
Dead-weight-capacity	1,250 tons
Length B.P.	196 ft.
Breadth	33 ft.
Depth	16 ft.
Power	400 B.H.P.
Engine-speed	190 R.P.M.

It will be noted that the weight of her hull and machinery is about 1150 tons on nearly 50 per cent of her loaded displacement. She is a single-screw vessel and is being fitted with a 400 b.h.p. four-cycle type six-cylinder, 11-2" bore by 19.6" bore Frichs-Diesel engine, built by the Frichs Engineering Works, Ltd., Aarhus, Denmark, who by the way have had considerable experience with the Brons type of oil-engine, better known in the U. S. A. under the name of the Hvid and Burnoil motors. The new Frichs-Diesel engine develops its power at 190 R.P.M. and is of the crosshead-type with enclosed crank-chamber, and in general appearance is not unlike the McIntosh & Seymour Diesel engine, having the long push-rods for actuating the valves. There also is a 35 b.h.p. Frich oil-engine driving an auxiliary air-compressor and ballast-pump. On deck there are three oil-engine driven winches. The propeller is of four-bladed design and has a diameter of 7 ft., and the intermediate shaft is fitted with a ball thrust-bearing. Filters are provided for both the fuel and lubricating oils.

POWER PLANT IN MARINE ENGINEERING WORKS

At the Basingstoke works of Sir John I. Thornycroft & Co., the British shipbuilders and engineers, are two 270 b.h.p. Sulzer-Diesel two-cycle oil-engines driving electric generators. They use tar-oil extracted from coal as fuel, and preparations are being made for the installation of a third engine. Except for some piston troubles these engines have filled expectations.

ITALIAN DIESEL-DRIVEN MOTORSHIP

Among motorships recently placed in service in Italy is the iron auxiliary Sc. Bk. "Blanche," owned by Quaglia & Galdini of Genoa. Originally this vessel was built in Scotland by A. McMillan & Son of Dumbarton, in 1877, but now is of Italian registry. A Kind Diesel-type two-cycle oil-engine, having four cylinders 17¾ in. diameter by 26 in. stroke, has been installed as auxiliary power. The length of the "Blanche" is 239.1 ft. by 39.3 ft. beam and 22.9 ft. moulded depth. The engine was built by P. Kind & Co. of Turin, who, by the way, recently purchased a large number of lubricators that were advertised in the columns of "Motorship."

A REMARKABLE OUTPUT

During the 4¼ years of the great war the well-known British shipbuilding and engineering firm of Sir W. G. Armstrong, Whitworth & Co., Ltd., produced the following:

Shells	14,500,000
Gun Cartridge Cases	21,100,000
Fuses	18,200,000
Guns	13,003
Gun Mountings	12,093
Aeroplanes	1,075
Airships	3
Warships and Submarines	47
Merchant Ships	22

In addition they built a number of marine Diesel oil-engines, repaired 521 warships and 236 merchant ships; fitted 62 other warships with armaments. The maximum labor employed at any time was 78,000 men and women, and the highest monthly wage bill was a little under $5,000,000,00. The latter will give an excellent idea of the moderate cost of engineering and shipbuilding productions in Great Britain. If we assume that Armstrong Whitworth averaged $1,000,000.00 per week in wages during the war the above enormous output was carried out at a total labor cost of but between $210,000,000.00 and $220.000,000.00 The same war production in the United States probably would have cost at least a billion dollars in labor.

POSSIBILITIES FOR A MOTORSHIP LINE TO THE DUTCH EAST INDIES

For motorships the Dutch East Indian Archipelago offers a particular attraction as a port of call because liquid fuel is produced there in considerable quantities. Those islands situated south of the Philippines and of Singapore, West of Australia, cover an area of the same length as from San Francisco to Philadelphia, and have more than forty million inhabitants. The distance from the Pacific Coast of the U. S. A. to the Island of Java is some 7,800 miles and from New York 10,182 miles through the Suez Canal.

The foreign trade of the Island amounts to more than $600,000,000.00 per year, in which figure the United States shares an important part. The imports as a class are heavier than the exported produce, which is very bulky, so that there is always a demand for export tonnage. Consequently for a return trip a vessel will be obliged to use her ballast tanks, which can either be filled with liquid-fuel, or with cocoanut-oil now produced to the extent of 100,000 tons a year. For the outgoing voyage it will be sufficient to take merely liquid-fuel for the single trip, which furnishes the advantage that the ship can carry more freight.

The shipping figures are interesting: in 1913 the trade with foreign countries was served by 3,483 steamers of an aggregate tonnage of fourteen-million tons. The principal ports are Macassar, Sourabaya, Samarang, Batavia, Belawan, Padang and Sabang on the Island of Way. In greater part of these harbors are quays and docks with modern equipment to secure quick unloading and loading of the vessels.

There are two passenger lines under the Netherlands flag, operating cargo-boats as well. the blue funnel had a regular freight service before the war and two German steamship lines called, these latter two of course will remain suspended for a long time. Meanwhile the Japanese flag has come in, but still a splendid opportunity is open for the Stars and Stripes. The fact that huge stocks have been piled up demonstrates the favorable chance to lay now the foundation for a regular line.

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"Motorship" Illustrated Patent Record*

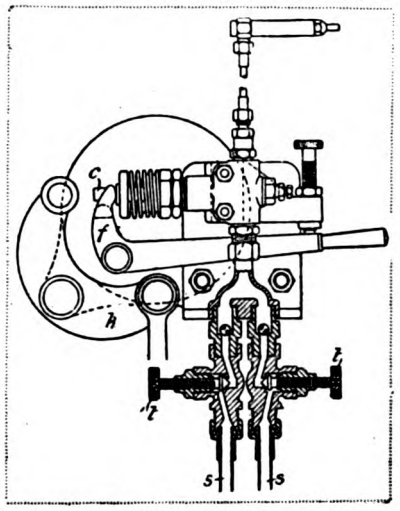
Selected Abstracts of Recent Published Patents of Internal Combustion Engines

Copies of original specifications may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

*Compiled and described by H. Schreck, Member American Society Mechanical Engineers

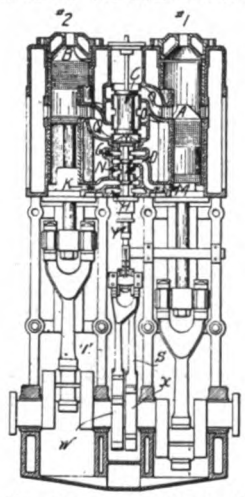
118,538. Dec. 15, 1917. Double-suction Fuel-Pump. E. W. Petter and H. Brook, of Messrs. Petters, Ltd., Yeovil (British Patent).

This patent refers to a fuel-oil pump suitable for a surface-ignition type of oil engine, fitted with two suction valves so that two liquid fuels may be used simultaneously or alternatively with a single pump.



1,284,490. Nov. 12, 1918. Starting and Scavenging of Two-cycle Engines. C. C. Terry, of Seattle, Wash.

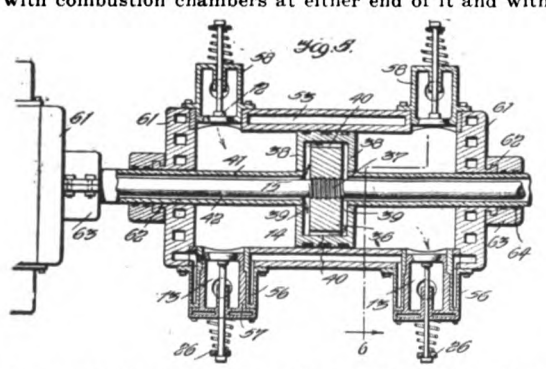
This invention refers to a novel arrangement of a two-cycle engine. The cylinders are arranged in pairs and between each such pair is provided a piston-valve which takes care of the distribution of scavenging and starting-air. The piston-valve is operated by a Stephenson link-gear, with one eccentric W for the ahead and another one X for the astern motion.



The piston-valve has two main bodies C and D, of which the upper one controls the scavenging-air to the upper or working part of the cylinders and its lower part either controls the starting-air to the lower part of the working cylinder, or when the engine is in operation it is the valve gear for the lower part of the cylinder which serves as the compressor of the scavenging-air. Assuming, for example, that our illustration represents the engine in the starting position and that the piston A is going to move upward, then starting-air would be admitted at M and the other piston while moving at the same time downward will compress scavenging-air and discharge same at K through the piston-valve into the scavenging-air receiver.

1,275,264. Aug. 13, 1918. Internal-Combustion Engine. L. B. Joyner, of St. Cloud, Minn.

This patent refers to a double-acting internal-combustion engine whose characteristic is a cylinder with combustion chambers at either end of it and with

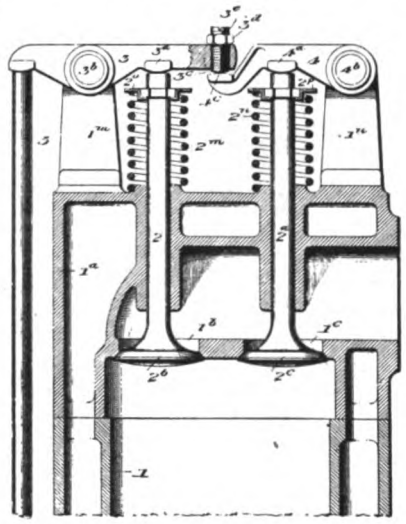


the respective valves for each chamber. The piston and piston-rod are watercooled, the water entering through a telescope pipe at the outer end of a tail rod of the piston rod, and is discharged through a reciprocating pipe, which is attached to the crosshead.

This patent is being reported for the sake of completeness of our record, otherwise it will hardly offer any novelty over what is already on the market.

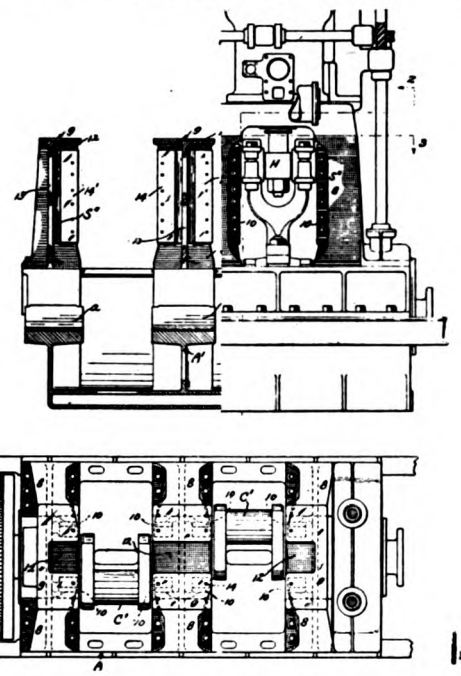
1,284,311. Nov. 12, 1918. Valve Gear. E. T. Gillard, of Hanover, Pa.

This invention relates to the operation of twin valves which are actuated by one push-rod, and which may be unseated at the same time and to the same extent.



1,284,255. Nov. 12, 1918. Frame Construction. G. C. Davison, of New London, Conn., Assignor to Electric Boat Co. of New York, N. Y.

This patent relates to a special frame construction, with which the frames, carrying the cylinders, are not arranged in the plane of the connecting-rod, but on



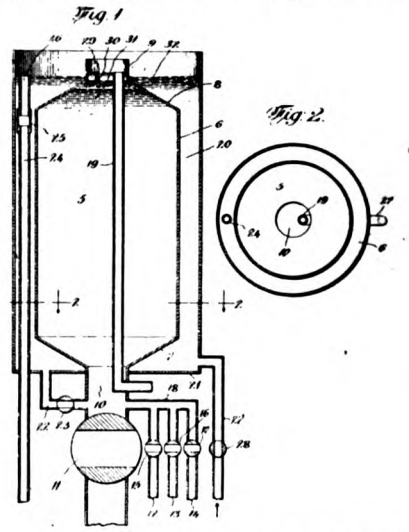
the centerline of the main bearings. Detachable guides for the crosshead slippers are arranged on either side of these frames. The advantage of this construction besides free accessibility to the crank drive is the relief of the longitudinal girders of the base-plate from bending stress.

A similar frame construction was used years ago on the very large marine steam-engines.

1,162,185. Nov. 30, 1915. Oil-Reclaimer, O. H. Nonnenbruch, of New Rochelle, N. Y., Assignor to De La Vergne Mach. Co., of New York, N. Y.

This invention covers an apparatus which object it is to purify automatically and to render fit for re-use lubricating oil which became impregnated with carbon, grease, etc., during its service in the engine. The principle underlying the process is precipitation as consequence of agitation.

The inner container 6 is to be charged partly with the impure oil at 13 and partly with fresh water at 14 which are then together thoroughly agitated by admitting compressed air at 12. During this agitation for the reaction of the oil the container is heated from the outside by warm water 20 which may be the discharged water of an oil-engine. When the mixture has been sufficiently agitated, to allow the completion of the reaction, the air is shut off and the mixture is allowed to rest and it will finally separate itself into three layers, the upper being pure oil, the bottom layer water, while the intermediate one will carry the impurities. Then the valve 23 will be opened and the liquid of the outer container being of greater specific gravity (only pure water) will raise the contents of the inner container and let overflow through pipe 19 the cleaned oil, that is, the upper layer 29—until to the moment—when the liquids of the inner and the outer container will be of the same specific gravity, that is, when all "oil" has been discharged through 19 and only water and dirt have been left. The interruption of flow is automatically secured by the arrangement of the top of pipe 19 being at a higher level than the

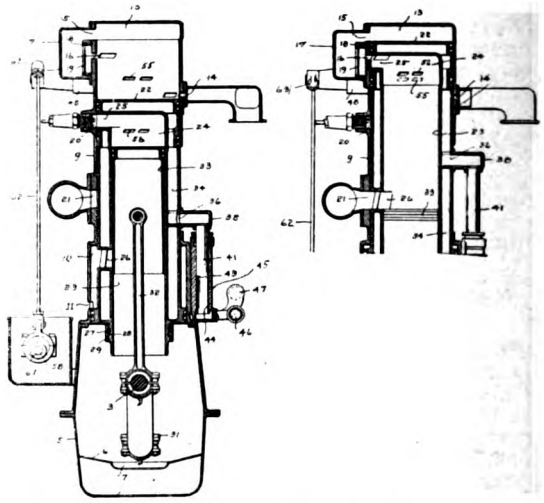


level of the outer container which is being maintained all the time by the overflow at 26 and a constant supply of fresh water at 27.

So far about 400 of these apparatuses are in operation in oil-engine and other power plants all over the country.

1,282,983. Oct. 29, 1918. Two-Cycle Engine with Opposed Cranks. C. H. Thie, of Toledo, O., and W. M. Buttler, of Toledo, O.

This invention relates to a two-cycle engine of which each cylinder has two pistons 33 and 22 which are impelled in opposite directions by the combustion of the charge in chamber 24. The connecting rod of the outer piston is fulcrumed on trunnions of the ring 29. This piston is of the differential type, the scavenging air being compressed in its ring space 10. This air will enter the cylinder at the moment when the ports 55 and 56 will register, that is, when the two pistons



approach their outmost positions, and blast out the burned gases through port 26 into manifold 21. A common horizontal piston valve 48 is arranged between each two cylinders through which the scavenging air is supplied to the respective cylinder. The air and fuel enter at 14, and this charge is precompressed during the working stroke, that is, while piston 22 is moving upward and will enter the working cylinder proper through the ports 16 and 25 when the piston is at its upmost center.

The cooling water enters and leaves through two telescopic tubes 41, which are arranged side by side, attached to the piston, and the cylinder is slotted to permit the movement of the header 38.

Notice

All Bound Volumes of "Motorship" for 1918 have been sold. It is possible that another supply may be available about April.

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